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COMPOUND EXPRESS ENGINE—PARIS, LYONS, AND MEDITERRANEAN RAILWAY.

A NEW type of express engine, which we illustrate, has recently been completed by the Paris, Lyons, and Mediterranean Railway Company.

The boiler of this engine is fitted with Serve tubes, and the working pressure is the highest yet used in an actual locomotive, namely, 215 lb. per square inch. The engine is carried on a four-wheeled bogie in front and on four coupled driving wheels, the trailing axle being under the after end of the fire box.

It will be seen that the two high pressure cylinders are outside, and drive the trailing wheels, while the two low pressure cylinders are inside, and actuate the leading drivers. The valve gear is so arranged that the driver can reverse all the slides with one motion.

The use of the Serve tubes has permitted the boiler to be shortened, the tubes being only 10 ft. long, or from 2 ft. to 3 ft. shorter than those used in the other engines of the company. Much weight has been saved, as well in the shell as in the quantity of water carried. The tubes have been made the subject of exhaustive experiment by the company, with the result that ninety engines are now being fitted with them. These engines are in course of construction at the company's works, Boulevard Diderot, Paris. The weight of the engine we illustrate is about 48 tons, thus distributed: Each bogie axle, 8·9 tons; leading driving axle, 15 tons; trailing driving axle, 15 tons. The grate surface is 25 square feet. The boiler, fire box, side frames, etc., are all of steel. The principal dimensions are as follows:

High pressure cylinders, diameter....		13·4 in.
Low " " "		21·25 "
Stroke		24·4 "
Diameter of driving wheels......	6 ft.	6·75 "
Heating surface, total.......		1,620 sq. ft.

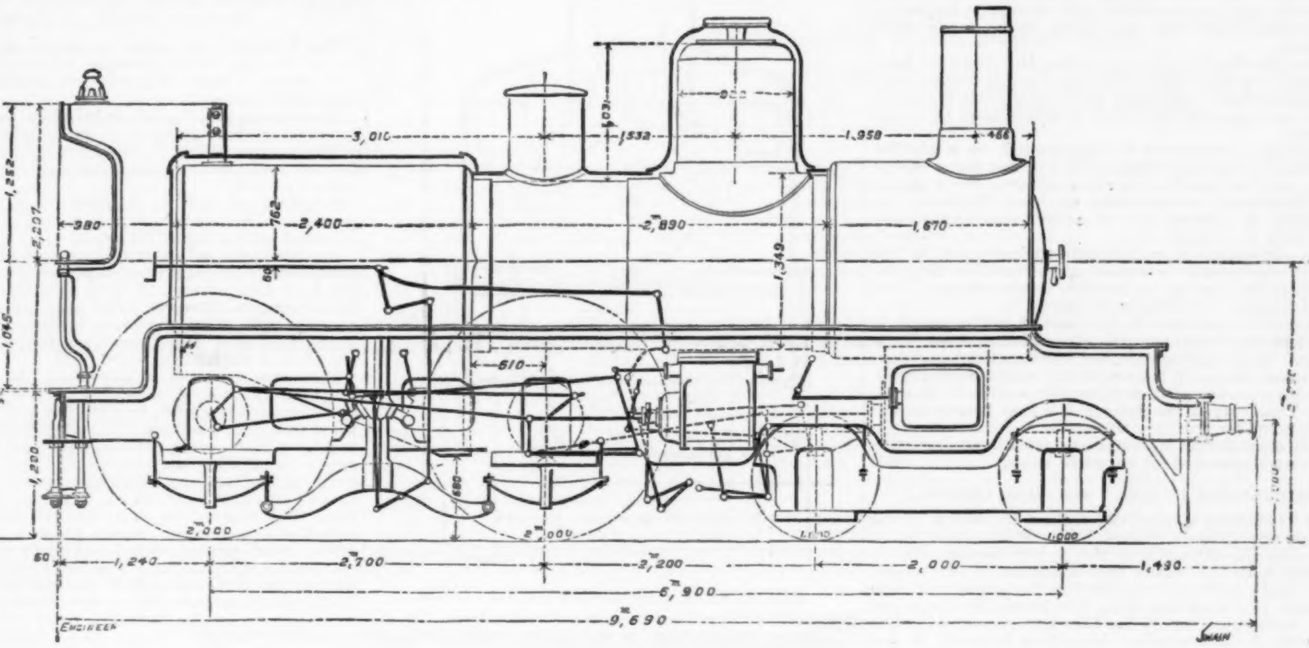
Further information is supplied by the dimensioned diagram. We are indebted to the courtesy of the chief and associate engineers of the line, MM. Baudry and Bland, for the information we have laid before our readers.

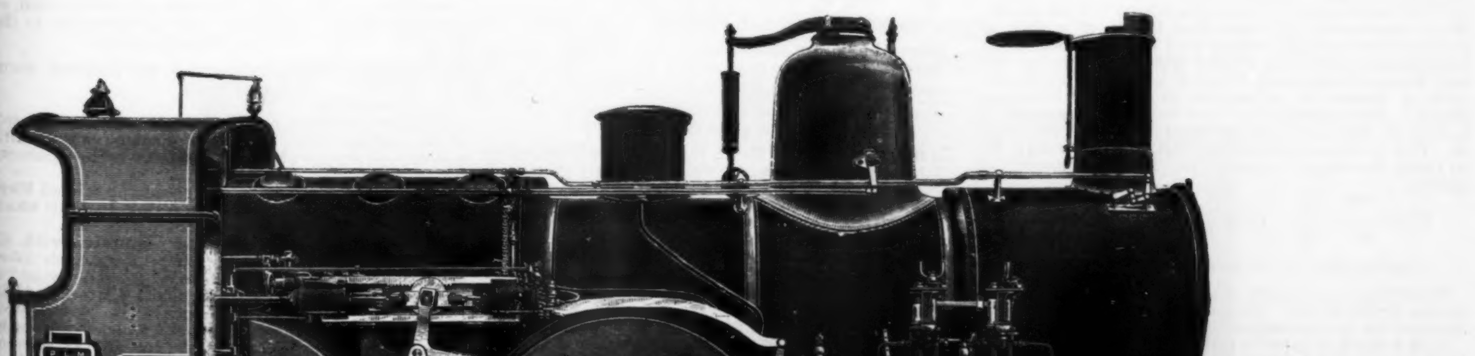
PAPER TESTING AT THE PRESENT TIME.

IN Germany, and other parts of the Continent, the testing of papers is carried out in a very complete way. The following is an abstract of a report published in the *Papier Zeitung* on the methods employed for this purpose, and laid before the Mid-German Paper Society, by Mr. W. Hertzberg, head assistant in the paper-testing department of the Charlottenburg Laboratory:

TENSILE STRENGTH OF PAPERS.

By the strength of a paper we understand the measurement of the resistance it offers to breaking or tearing strains. This resistance is always greater in the direction of the length of the web of paper, as it is made on the paper machine, than across the web. On the other hand, the amount of elongation, which is measured while determining the breaking strain, is greater in the direction across the web than parallel to it. The tensile strength of the sheet, both across and parallel to the web, is determined separately and the average values recorded.





COMPOUND LOCOMOTIVE, PARIS, LYONS, AND MEDITERRANEAN RAILWAY.

To ascertain the direction corresponding to the motion of the paper machine, in any sample of machine-made paper, a circular piece is cut and placed on the surface of water, when it will be observed to roll up. The diameter of the disk where it is not curved indicates the direction of the length of the web. Other methods are also used for ascertaining this, but are not so good as the foregoing.

The strips of paper used for ascertaining the tensile strength and elongation are cut to the following size, viz.: 180 mm. long by 15 mm. broad. Five strips, at least, are taken from different sheets and representing the length and across the web in order to obtain good average values. These strips must be carefully cut; the edges should be smooth and run parallel. Cutting tools are provided for this purpose, consisting of an iron ruler and plates of zinc or glass. A slight deviation from the standard breadth does not influence the result much.

Before determining the tensile strength and elongation, careful attention must be paid to the amount of moisture in the atmosphere. The breaking strain of paper decreases with increase of moisture in the air, while under the same influence the percentage amount of elongation increases. The humidity of the atmosphere is also very important when testing animal-sized papers, and should on no account be overlooked. Indeed the breaking strain values can only be compared when they are obtained in atmospheres of equal humidity. The percentage atmospheric humidity chosen is 65, because it is much easier to add moisture to the atmosphere than abstract moisture from it. The former is done by boiling water in the room or by wetting the floor. The instrument in use for measuring the humidity of the air is Koppe-Saussure's air hygrometer, the readings from which are reliable, provided the instrument is adjusted once a week. Before testing, the strips of paper are placed in the room containing an atmosphere of the above percentage humidity, for at least half an hour.

Horack's Dasymeter.—A number of machines are used for estimating the tensile strength and percentage elongation. The above named, which is so well known and much used, is uncertain, and cannot be employed for investigations that lay claim to be made with accuracy.

In the *Hartig-Rensch Apparatus*, the strips are torn by means of a spiral spring giving a pencil tracing, and at the same time a diagram from which the breaking weight and amount of stretch is determined by measurement.

Wendler's Apparatus is constructed on a similar principle, the power being also applied by a spiral spring, but the results are given direct. By a moveable adjustment, constructed by Prof. Martens, the apparatus is thrown out of action immediately the paper strip is broken.

These apparatus provided with springs must be frequently readjusted or tested to prove that they are correct, as the springs are subject to alterations. This should be done every three months.

Chopper's Apparatus is constructed on the principle of a declivity balance, the strips being torn by a weight. Spiral springs are not used on this machine. The instant the strip is broken the power and expansion levers are released, but remain unaltered in position. This form of machine is the best known at the present time for ordinary work.

Many other forms of apparatus are known but cannot be recommended for accurate work.

CALCULATION OF THE "BREAKING LENGTH."

The "breaking strain" determined by means of one of these apparatuses cannot by itself be employed to determine the strength of the paper, because this is dependent on the width and thickness of the paper. If one could determine exactly the thickness and thus calculate the sectional area, the breaking strain per cubic millimeter would be the best measure for the valuation of the strength. Since this, however, is not possible, one may calculate, according to the proposal of Prof. Reubaux, the "breaking length" of the paper. We understand by this term that length of a strip of arbitrary but uniform width and thickness which, in consequence of its own weight when hung up by one end, breaks at the point where it is held. This length may of course be calculated from the "breaking strain." For example, G = the weight in grammes of a strip of 0·18 meter, which breaks under a strain of K. It is to be calculated how long the strip must be in order to weigh K grammes. X = this length in meters.

$$\text{Then } \frac{0{\cdot}18}{G} = \frac{X}{K} \quad \text{or } X = \frac{0{\cdot}18 \times K}{G} \text{ meters.}$$

RESISTANCE TO RUMPLING AND RUBBING.

These form a necessary supplement to the values for tensile strength, etc. No mechanical apparatus is constructed for this investigation.

Half a sheet of paper is rolled up and is then held by both hands and rubbed, after the manner employed by women when washing clothes. With a little experience it is not difficult to distinguish eight different degrees of resistance, the number customarily adopted in the testing establishment at Charlottenburg, viz.:

0 Extremely weak	4 Moderately strong
1 Very weak	5 Strong
2 Weak	6 Very strong
3 Medium	7 Extremely strong

At first sight it would appear that the difference in the stages of the above classification is so small that it is scarcely possible to separate them with certainty; but this uncertainty vanishes as soon as the operator has acquired sufficient practice.

THICKNESS OF THE PAPER.

The measurement of a heap of paper with a millimeter scale and calculating the thickness of a single sheet from the total number in the pile has been found to be inaccurate. The instrument used for measuring the thickness is so constructed that a micrometer screw provided at one end with a die is worked toward another die, also provided with a screw, fixed to the stock of the instrument. The paper is laid between the dies and the thickness ascertained by moving one of the screws to which a scale is attached. One division of the scale corresponds to 0·005 of a millimeter.

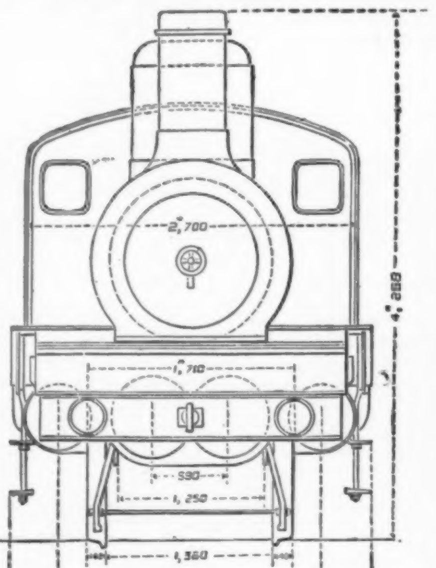
MINERAL RESIDUE OF PAPERS—ASH.

The constituents of the paper left after burning and perfect ignition of the black carbonaceous matter is called the ash. This is derived partly from the fiber, partly from the sizing materials, but in the majority of cases from the loading materials. Pure fibers, chemically prepared from fibrous plants, etc., contain, as a general rule, less than one per cent. of ash. For example:

	Per cent.
Beechwood	0·43
Lime	0·39
Wood flour (white pine)	0·41
Bleached linen	0·94
Bleached cotton	0·76
Bleached pine cellulose	0·53
Unbleached linen	0·76
Unbleached cotton	0·41
Hemp	9·69
Bleached straw pulp	0·86–1·22
Mitscherlich cellulose unbleached	1·25
Sulphite pulp bleached	0·42

These are not absolute values; they depend upon the place of growth of the plant and the mode of preparing the pulp, etc.

Balances are specially constructed for determining the ash or mineral matter. The best known are Post's ash balance and Reimann's substitution balance. The latter is the more perfect apparatus. In both, the burning operation takes place in a network of platinum wire and the amount of ash is read off in per cents. For correct determinations a sample of the paper is dried at 100° C. till the weight is constant, and then a weighed portion of this put into a platinum crucible and ignited till all carbonaceous matter is burnt off. An analysis of the ash is afterward made in order to gain a knowledge of its composition.



EXPRESS ENGINE—LEADING END.

MICROSCOPICAL EXAMINATION OF PAPERS.

Three things are aimed at in the microscopical examination, namely, to determine:

1. The kind of fiber.
2. The quantity of fiber.
3. The state of the fiber.

In order to arrive at these, it is first of all necessary to carefully choose a sample and previously prepare it for treatment with certain fluids.

Small pieces are cut from different parts of the sample sheets and boiled for about a quarter of an hour in a dilute (1 per cent.) solution of caustic soda, to dissolve the size and starch. The pulp, etc., is then washed with water on a fine sieve and transferred to a glass flask and shaken up with water to separate the fibers from one another.

Water, or water with glycerine, is not suitable for preparing the fibers, as they remain uncolored, and are in consequence difficult to distinguish. In the Charlottenburg testing establishment a solution of iodine and aqueous potassium iodide (20 c.c. H_2O; 1·15 grammes iodine; 2 grammes KI, and 1 c.c. glycerine) is preferably used; or an aqueous solution of iodine and potassium iodide containing chloride of zinc. In the latter case the fibers must be carefully dried between filter paper before treating them with the solution. The general appearance of the fibers after soaking in this solution will be as follows:

	Solution of Iodine in KI.	Solution of Iodine in KI with $ZnCl_2$.
Linen and hemp	Brown	Reddish to brown
Cotton	"	"
Wood pulp (chemical)	Colorless to gray brown	Bluish to blue
Straw pulp	" "	"
Esparto pulp	" "	"
Jute bleached	" "	"
Wood flour (mechanical wood pulp)	Dark yellow	Citron yellow
Jute unbleached	"	"

These colorations cannot be regarded as definite reactions. They only indicate in a general way the presence of certain fibers. A decision should always be based on the anatomical structure of the fibers themselves.

A solution of sulphuric acid and iodine, proposed by Hohnel, colors fibers in a similar way to the above iodine and zinc chloride solution.

Linen and Hemp.—The anatomical characteristics of these two are: The regular structure of the fibers, the broken ends, and the straight, narrow, hollow canal. Natural ends seldom occur.

Cotton fibers possess a wider hollow canal, are flat and frequently twisted. Their membrane walls often show lattice-formed stripes. Natural ends seldom occur.

Cellulose fibers, prepared from pine wood (*Coniferæ*), are distinguished by pitted cells or pores, and many natural ends, which have mostly a blunted form.

Cellulose from leaf woods is known and distinguished by the heterogeneous forms of numerous vessels which are present.

Straw pulp is especially recognized by the more or less strongly marked epidermal cells. The parenchyma and bast cells serve further to establish its presence. The isolation of the different kinds of straw pulp is difficult, and is of little value.

Esparto pulp shows the same kind of cells as straw, but in smaller number. The large thin-walled parenchyma cells are absent in esparto, while they are peculiar to straw, but in many cases are present in smaller quantity.

Jute is best known by its irregular hollow canal, the width of which often passes from one extreme to another within a short length. Sometimes within the microscopical field it is seen as a narrow line, while in others it embraces for the most part the width of the fiber. In packing papers we find, moreover, the bast cells chiefly united to thick bundles, an appearance which in fine papers, in which the jute is bleached and strongly beaten, would not otherwise be observed.

Wood flour (mechanical wood pulp) is very easily known by its yellow color, its irregular structure, and torn appearance, its strongly marked pores, and its radiated cells.

QUALITATIVE TESTS FOR WOOD PULP (GROUND WOOD OR WOOD FLOUR) IN PAPER.

The behavior of certain reagents on woody fibers serves to show their presence without the aid of the microscope. These reagents are applicable with certain restrictions.

An aqueous solution of naphthylamine acidified with hydrochloric acid (5 grammes naphthylamine dissolved in 50 grammes of hot H_2O and 1 to 2 grammes HCl, and filtered) colors papers containing mechanical wood pulp orange yellow.

Sulphate of aniline (5 grammes dissolved in 100 grammes of water) colors papers containing mechanical wood pulp a beautiful bright yellow.

An alcoholic solution of phloroglucin, containing hydrochloric acid (4 grammes phloroglucin dissolved in 25 c.c. of alcohol and 10 to 15 grammes concentrated HCl), colors mechanical wood pulp papers a powerful carmine red. This reaction, introduced by Wiesner, is the best and most beautiful for ascertaining the presence of mechanical wood pulp.

There are, however, other woody fibers employed in the manufacture of paper, which are colored by the above quoted reagents, in a similar way to mechanical wood pulp; for example, the refuse from coarse hemp and linen rags, as also unbleached jute, both of which occur in packing and envelope (bag) papers. The reaction is therefore somewhat restricted. It should also be noted, with reference to the phloroglucin reaction, that some dyes, *e. g.*, metanil yellow, used for coloring and shading paper, yield a red color with acids. Such papers would obviously give a mechanical wood pulp reaction. The aniline sulphate reaction will enable the operator to distinguish in such case. If any doubt should arise in the investigation of wood pulp papers by the chemical reactions, resort should be taken to the microscope, and a decision founded on the anatomical structure of the fiber.

Solutions of the above strength are always used, so that the operator may form some judgment as to the quantity of mechanical wood pulp present.

QUANTITATIVE DETERMINATION OF GROUND WOOD IN PAPER.

A. *Color Tests.*

Godicke produces a yellow stain with aniline sulphate, and compares the depth of color obtained with a scale, the shades of which represent certain percentages of mechanical wood pulp.

Dr. L. Gottstein proposes to count the colored fibers occurring within a certain area, forming a table which could be used for determining the percentage.

Dr. Wurster uses filter paper saturated with dimethylparaphenylendiamine (*di papier*) which colors wood flour red. A small piece of the "di papier" is saturated with water or acetic acid (1–2 drops) and laid between the folds of the paper to be investigated. The paper is colored red if ground wood is present in it, and after drying, the stain, as in the case of Godicke's test, is compared with an empirical scale.

In the Charlottenburg testing establishment the following method is employed. Small pieces of paper, containing known percentages of mechanical wood pulp, are steeped in a phloroglucin solution together with a sample of the paper to be tested. These are then placed on a glass disk and the shade of the sample compared with those of the standard papers. By comparing the nearest shade in transmitted and direct sunlight a near estimate of the percentage of mechanical wood pulp in the paper can be formed. This method is especially valuable in estimating small quantities of wood (1 per cent. can be distinguished) within the limits of 1–5 per cent. The thickness of the paper is taken into consideration.

B. *Analytical Methods.*

Dr. Muller suggested to dissolve cellulose (pure fiber) in cuprammonium, by which under certain precautions mechanical wood pulp is not attacked. Prof. Finkener has shown that this method is unworkable.

Godeffroy and Coulon employed the property which ground wood possesses of separating metallic gold from a chloride of gold solution. (*C. T. J.*, 209, p. 333.) One hundred grammes of pine wood should separate 14 grammes of metallic gold. This yields a figure as a basis for the estimation of the percentage of wood in paper. Prof. Finkener has, however, shown that the

reducing action of the wood is not finished after 14 grammes of gold have been precipitated, and that on further boiling the reduction of the gold chloride still continues. This method is therefore not applicable for the purpose in view.

Benedikt and Bamberger show clearly, by means of S. Leisel's methoxyl method, that lignin (woody substance) contains a somewhat high proportion of the methyl group. We understand by this term that quantity of methyl in tenths of a per cent. which separates in the form of methyl iodide, when the substance is boiled with hydriodic acid. The methyl iodide when passed into silver nitrate solution precipitates silver iodide, and may thus be determined. The following was found on an average for:

Pine wood methyl number	= 22·6
Fir " " "	= 24·5
Ash " " "	= 22·6

The determination must be carried out with great care. It is not practicable if the paper contains sulphate of lime or barium, and therefore an analysis of the ash is necessary before testing.

An exact determination of the quantity of wood in papers is of importance in cases of dispute only. In most cases it is simply necessary to estimate the quantity present to within 5 per cent.

DETERMINATION OF THE KIND OF SIZING.

A. *Animal Size.*

1. The largest possible quantity of the paper (say one or two sheets) is boiled in water, filtered and freshly precipitated yellow oxide of mercury added to the filtrate and this again boiled for 15 minutes. If animal size (gelatine) be present, the mercuric oxide will be reduced to metallic mercury, the yellow color being transformed to black. The black precipitate is placed on a filter and washed first with water and then with diluted hydrochloric acid; a black residue should remain on the filter. This reaction is not very sensitive, and therefore has been replaced by the following one.

2. A sheet of the paper is digested in boiling water and the liquid filtered. When the filtrate is cold a few drops of tannic acid solution are added, when, if animal size is present, a thick, milky-white precipitate will be formed.

B. *Resin Size.*

1. Half a sheet of the paper is digested in alcohol in a warm place and the fluid poured into a large volume of distilled water. A white turbidity is formed if resin size is present. This reaction is not very sensitive, but its sensitiveness can be increased by adding a few drops of acetic acid to the alcohol.

2. A few square centimeters of the paper are boiled several times in a flask with 3 to 4 c. c. of acetic acid, and the fluid then largely diluted with water. If resin is present, a thick white precipitate is formed.

3. Marawski macerates a few pieces of the paper in anhydrous acetic acid and, after cooling, allows a drop of concentrated sulphuric acid to flow down the side of the glass vessel into the mixture. In the presence of resin a red coloration is formed which gradually fades.

4. At Charlottenburg the following simple method has been adopted. Four or five drops of ether are placed on the paper to be tested and allowed to evaporate. If resin-sized, the edges of the spots when held up to the light will appear transparent. This method is recommended on account of its simplicity and especially in the investigation of books, prints, etc., as these are not damaged.

C. *Starch.*

Starch, as a size, scarcely ever occurs alone; it is, however, used with animal and resin size.

The iodine solution used for the microscopical purposes is diluted with water till it is of a pale yellow color. This solution produces a blue coloration on papers containing starch.

DETERMINATION OF THE AMOUNT OF SIZING.

Leonhardi and Post drop over the surface of one side of the paper a few drops of a solution of chloride of iron (1·531 per cent. Fe.) These drops are allowed to act on the paper a few seconds, according to its thickness, then the remainder of the solution is removed with filter paper. The other side of the paper is then streaked with an aqueous solution of tannin, and if the paper be not well sized, black flakes appear, otherwise there is no change.

Schluttig and Neumann have modified this method. They allow the chloride of iron solution to flow over one side of the paper held in an oblique position and the tannin solution over the other.

The degree of sizing often varies in a sheet. At times one-half of it is well sized while the other half is not.—*Chem. Tr. Jour.*

FRAME FOR SINGEING COTTON THREAD.

WHEN, in cotton work, the operation of spinning, properly so called, is completed and the cotton thread is finished, the latter cannot always be sent at once to the reel to be made into skeins. The thread, in fact, presents inequalities in size and an unevenness and villosity of surface due to the very nature of the crude material, and which the processes of spinning cannot prevent. Such villosity, which is of no account and even advantageous for certain fabrics, constitutes a serious imperfection for fancy cottonades, laces, satins and velvets. It is got rid of by the operation of singeing.

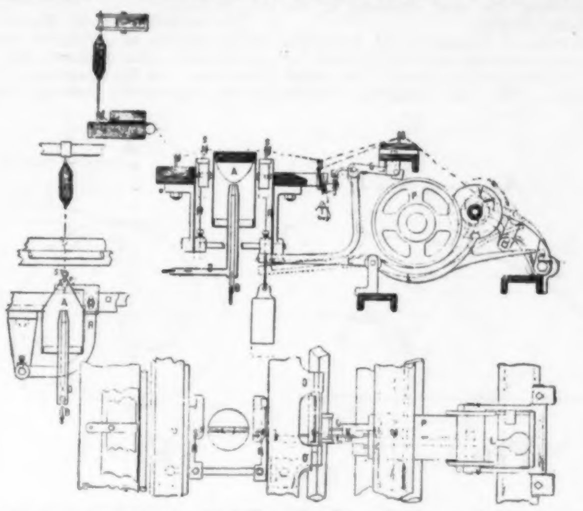


FIG. 2.—DETAILS OF THE NEW SINGEING FRAME.

A, burner; B, tube through which the gas enters; D, tube through which the air enters; E I O G, dynamometer movement; R S, movement of the thread guide; L, lever for placing the bobbin upon the pulley and the thread upon the flame.

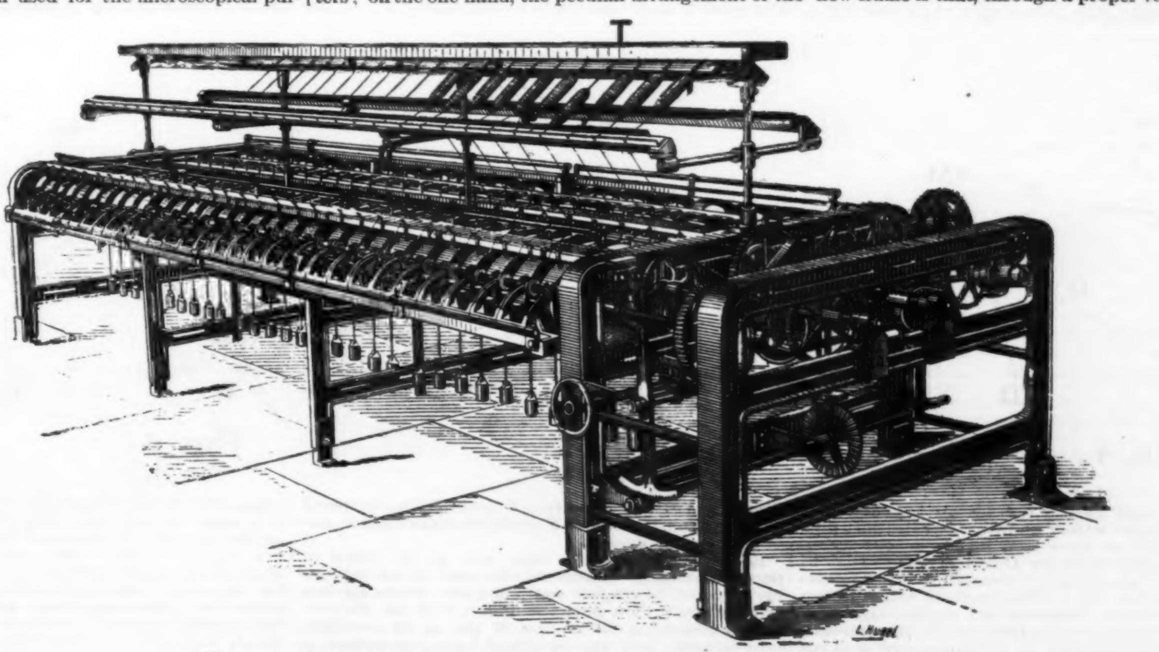


FIG. 1.—FRAME FOR SINGEING COTTON THREAD.

The thread is unwound with a calculated velocity between two bobbins spaced from 50 to 60 cm. apart. In its passage its traverses two or three gas flames situated at a distance of about 10 cm. from each other. It passes through the center of these and nearly at the base of the luminous part. The passage is sufficiently rapid to prevent the thread from being burned. The villosities are converted into a friable carbon and fall of themselves, on issuing from the flame, in the form of a grayish dust. Women and girls are almost always employed to watch these frames.

The new singeing frame of Messrs. Villain, Sons & Co., of Lille, is distinguished from all other apparatus of the kind hitherto employed by two principal characters; on the one hand, the peculiar arrangement of the burner, which, for the smallest consumption of gas possible, gives a maximum of width of flame and of temperature; and, on the other hand, the arrangement of a rapid thread dynamometer which ungears both the bobbin of the driving pulley and the thread guides or burners.

The burner consists of a large cast iron tube forming a reservoir. It is closed beneath by a plug, traversed by two concentric tubes, one of which leads the gas, and the other the air derived from a reservoir in which it is compressed by a ventilator. At its upper part, this tube is flattened so as to form two inclined planes that leave between them a long narrow slit upon which the combustion of the gas is effected. The two tubes which lead the air and the gas are each provided with a cock that permits of regulating the proportions of the mixture in advance. There is thus obtained a blue and very hot flame of great steadiness. On leaving the supply bobbins, the threads wind around bobbins with horizontal axes carried along through contact with the driving pulleys against which they rest. The velocity with which the threads move is thus uniform, whatever be the size of the bobbins.

The threads are supported by two guides, one in front and the other behind. Every time a breakage occurs, a very sensitive thread dynamometer separates these guides by moving them laterally, and at the same time arrests the bobbin through a cam that lifts it slightly from its driving pulley.

After the break has been repaired, it suffices to bear upon a small lever, placed in front of the bobbin, in order to set the latter in operation.

This new frame presents a real superiority over those that have been employed up to the present.

The great width of the flame permits of obtaining a greater regularity of combustion of the fibers, and, consequently, a more perfect singing. With an equal number of bobbins, this frame consumes a quantity of gas nearly equal to that consumed by other frames, but produces double or triple the quantity of singed thread. The uniformity of the singeing is much greater, and this is a matter of serious importance in threads designed to be dyed.

By reason of the relatively great velocity with which the thread passes through the flame, the latter removes only the down without heating the central fibers, and without, in consequence, diminishing the strength of the thread, as always occurs in the systems with slow passage through one or more flames.

Finally, one of the important advantages of this new frame is that, through a proper ventilation, it permits of assuring the healthfulness of singeing rooms, which, from a hygienic point of view, are the most dangerous portions of cotton spinning mills. When one enters a singeing room, he experiences a mixed sensation of heat and suffocation. Toward the end of the day the heat rises to 34° or 35° C. The atmosphere is heavy, an odor of burned thread pervades the room, and one experiences a sensation of acridity in the throat and a smarting under the eyelids. The products of combustion are dust and deleterious gases. The dust of singeing is a mixture of carbonized fibers and molecules of carbon. It is much more irritating

and noxious than the normal cotton dust, because it is more easily capable of entering the respiratory organs. The deleterious gases derived from the incomplete combustion of the illuminating gas are composed mostly of carbonic acid with a certain proportion of oxide of carbon and a few other carbureted elements.

It is evident that a hot and vitiated atmosphere like that just referred to can be but extremely unhealthful to the women and girls whose business it is to run the singeing frames. So, for this work, they need a certain period of acclimation, during which they experience more or less grave organic disorders. As a general thing, they do not pursue this occupation for many years, and are subject to a certain number of troubles, the principal of which are eye diseases, headaches, sweats and fainting fits, and diseases of the digestive and respiratory organs.

The remedy for this state of things would evidently be the possibility of fully aerating and ventilating the singeing room so as to freshen and purify the atmosphere. Unfortunately, with the singeing frames hitherto employed, such ventilation cannot be effected, because it is impossible to open the windows, the very nature of the work being opposed to it. Provided there is an aerial current in the room, the flames flicker and the singeing becomes irregular. Sometimes the thread escapes the action of the flames, and sometimes it is burned. The result is that the windows can scarcely be opened except during a suspension of work, and this is inadequate to purify the atmosphere.

With this new singeing frame, on the contrary, the necessary ventilation can be much more easily assured. The mixture of air and gas that escapes from the burner makes its exit with a pressure greater than that of the atmosphere. The result is a great steadiness of the flame, which is much less sensitive to the action of currents of air, that do not make it flicker as happens with other singeing frames, and, consequently, the aeration of the room becomes easier.—*Le Genie Civil.*

ROBERVAL'S METHOD OF DRAWING TANGENTS.

By Prof. C. W. MACCORD, Sc.D.

CONSIDERING a curve as the path of a moving point, the nature of that curve depends upon the law according to which the point moves. More often than not this law is stated in a manner which gives, not the actual motion of the point at any particular instant, but its components. And Roberval's method of drawing a tangent to the path consists merely in finding the resultant when the components are given. It is remarkable that so simple, elegant, and direct a process which also exhibits most clearly the reason for each step, should not be more widely known. But the only allusion to it which we have seen in any mathematical treatise is in a little work on Descriptive Geometry by J. F. Heather; who makes in relation to it the following curious remark, viz.: "This method, which Roberval invented before Descartes had applied algebra to geometry, is implicitly comprehended in the processes of the differential calculus, on which account it is not noticed in elementary mathematics." Which appears a singular reason for neglecting to explain operations which are easily understood by those to whom the calculus is an inscrutable mystery.

In dealing with plane curves, these operations involve only the following elementary propositions relating to the laws of motion and its representation, viz.:

1. If a material point receive a single impulse, the motion imparted thereby may be represented in direction by a right line, and in velocity by a definite portion of that line.

2. If it receive simultaneously two impulses, the motion due to each may be represented by the adjacent sides of a parallelogram; and the resultant, or actual motion of the point, will be represented in magnitude and direction by the diagonal passing through their intersection.

The application of these principles is best shown by a few examples. The cycloid, Fig. 1, affords a good illustration; the rolling of the circle upon its tangent consists of a rotation about its center, indicated by the arrow *a*, combined with a translation in the direction of the tangent, indicated by the arrow *b*, and at any point P in its circumference, the linear velocity of the rotation is equal to the linear velocity of the translation. In order then to construct the tangent at P, draw P A perpendicular to the radius P C, and P B of the same length, in the direction of the translation. There are the components, and completing the parallelogram, P E is the resultant motion and tangent to the cycloid.

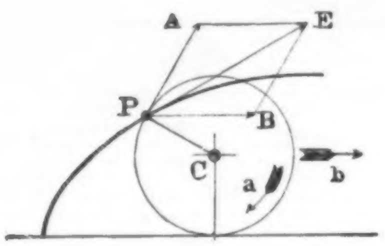


FIG. 1.

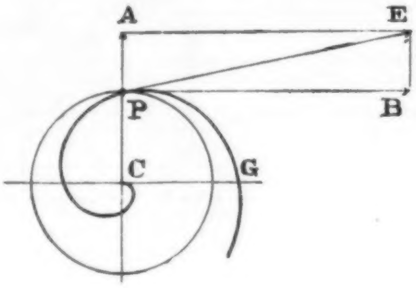


FIG. 2.

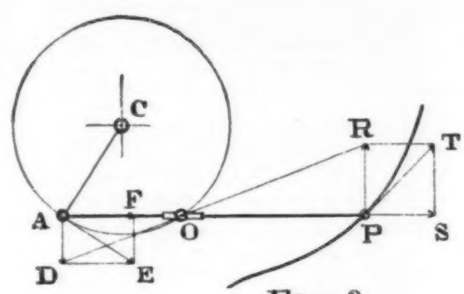


FIG. 3.

The equable spiral, Fig. 2, is the path of a point which travels at a uniform rate along a line which revolves, also at a uniform rate, about a fixed point on that line. In the diagram, C being the pole, the point moves outwardly through the distance C G in one revolution; let it be required to construct the tangent at P. First suppose the radial motion to be arrested: then in the time of one revolution the point would describe the circumference of the circle whose radius is C P. Next suppose the revolution to be arrested; then in the same time the point would travel along C P through a distance equal to C G.

Draw, then, P B perpendicular to C P, and P A in the direction C P, respectively proportional to the circumference just named and to the radial expansion C G; these are the components, whose resultant P E represents the actual motion of the point at the instant, in direction and in velocity, and is therefore tangent as required to the spiral path.

The same principles may often be conveniently employed to determine the components when they are not given directly. For example, in Fig. 3, a line A P, of given length, passes always through a fixed point upon the circumference of a ½ circle which is the path of one extremity A of that line. The other extremity, P, traces a curve called the limacon. In the diagram the arrangement is shown as the skeleton of a mechanical device, A P being a rigid bar sliding through a socket pivoted at O, and A C a crank jointed at A to the bar; the latter then slides endlong through the point O, and at the same time turns about it as a center. The motion of A at the instant may be represented by A E perpendicular to A C, and may be resolved into the components A F in the line of the bar, and A D perpendicular to it. The latter alone would cause A P to rotate about O, giving to P a motion P R perpendicular to A P and limited by D O produced. The point P must also have a component P S in the direction A P, and equal to A F; completing the parallelogram, the diagonal P T is the resultant motion, and tangent to the limacon.

Roberval's method is thus seen to be based on purely kinematic considerations, and to be admirably adapted to graphic constructions. In its application, however, care must be taken that all the conditions governing the motion of the point are taken into account, and the resultant fully determined in magnitude as well as direction. At first sight this precaution may appear self-evident and the advice superfluous; but curiously enough it seems to have been overlooked in the only illustration given by Mr. Heather in the treatise referred to. This is the case of the ellipse traced by a pencil P, Fig. 4, moving so as always to keep taut a string whose ends are fastened at the foci A and B: in relation to which he says: "In fact, since the length of the string is constant, the distance B P is lengthened at each instant of the motion by the same quantity as A P is diminished. The velocity of the describing point in direction B P is therefore equal to the velocity in the direction P A. If, then, equal straight lines be cut off from P A, and from B P produced, and the parallelogram P M R Q be completed, the diagonal P R of this parallelogram will be the direction of the motion of the generating point at P, and consequently the tangent to the curve at this point." He adds, "It is clearly seen from this, that in the ellipse the tangent bisects the angle A P M, formed by one of the focal distances and the production of the other; that the angles B P S and A P R are equal to one another, and that the curve must have the property of reflecting to one of the foci rays of light emanating from the other."

The same construction is fairly applicable to the hyperbola, with the modification that since in that curve the *difference* between the focal distances is constant, the describing point must either approach, or recede from, each focus at the same rate. Thus in Fig. 5, P M in the direction B P is equal to P Q in the direction A P, and the completed parallelogram gives P R as the tangent to the curve at P. The diagram shows the skeleton of a mechanical device, two rods being jointed together at P, and sliding through two sockets pivoted at the foci A and B. The means of controlling the motion of P so as to preserve the constant difference of the focal distances is not shown, nor is it necessary to the argument. Obviously the same device is applicable to the ellipse, means being provided to keep the *sum* of those distances constant.

Now it is to be observed that in these two cases mention is made only of the rates at which the describing point approaches or recedes from the points A and B. In these two cases those rates are equal; but as nothing is said to the contrary, it is fairly to be inferred that the same argument and the same construction would hold good if they were not equal.

In illustration, let the point P, in Fig. 6, recede from A twice as fast as it does from B; then setting off P Q equal to twice P M, and completing the parallelogram, the diagonal P R should on the above hypothesis be the resultant motion and tangent to the path of P.

But the figure is purposely so drawn that A P is equal to twice B P; and since the rates of approach or recess have always the same proportion to each other, the path of P under these conditions is the circumference of a circle, D P E, whose center C lies upon the prolongation of A B, the diameter D E being determined by the proportions, $\frac{A\,D}{D\,B} = \frac{A\,E}{B\,E} = \frac{A\,P}{B\,P}$ (see Todhunter's Euclid, Appendix, 55); but it is perfectly obvious that P R is not tangent to that circle.

It is equally clear that if in the last three figures P were a free point in space, subject only to the condition of receiving two simultaneous impulses which separately would impart the motions P M, P Q, then P R would in each case truly represent the resultant motion in both direction and velocity. But it is *not* a free point in either case; and the fallacy of Mr. Heather's exposition above quoted lies in neglecting the important consideration that P is always the intersection of two right lines which rotate about the fixed centers A and B; and can neither approach nor recede from either of those centers without such rotation. His construction seems at first sight plausible, and the more so because it gives the true *direction* of the tangent for all the conic sections, which misled the writer, in a previous article (see SCIENTIFIC AMERICAN SUPPLEMENT, No. 537), into applying the construction to those curves, in illustration of the utility of Roberval's method. But the fact that it gives the true direction is a consequence, and not the reason, of the property that the tangents bisect the angles between the focal lines, and depends upon the circumstance that with reference to the focal points, the rates of approach or recess are equal: for the assumed rates it does not (except in a special case to be mentioned subsequently) give even for these curves the true magnitude of the resultant; and when those rates are un-

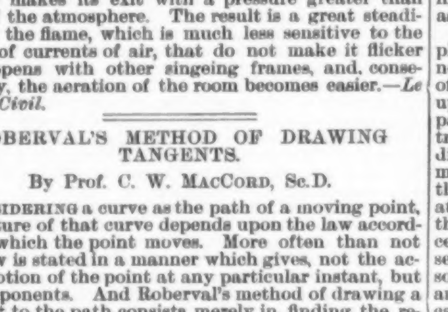


FIG. 4.

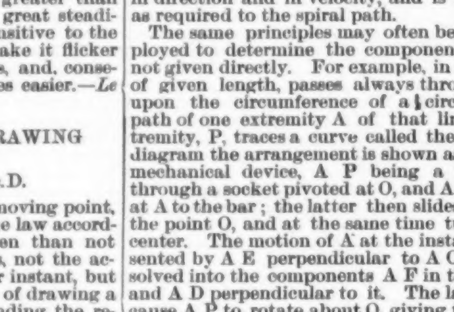


FIG. 5.

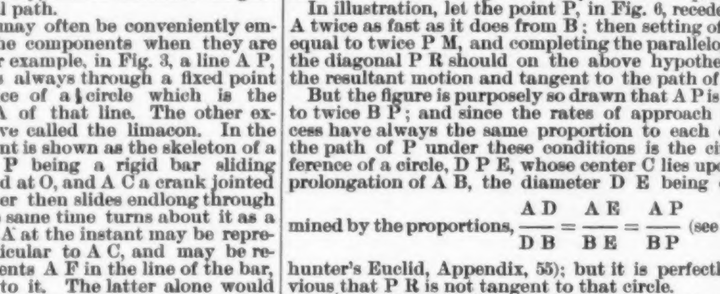


FIG. 6

equal, as in Fig. 6, the construction is in general, as above shown, erroneous in every particular.

Let us therefore now turn our attention to the general problem, viz.: Given two right lines, rotating with given velocities about fixed centers, to determine the motion of their intersection. In Fig. 7 the lines are represented as two rods, turning about the pivots A and B, and sliding through two sockets which are pivoted to each other at P.

1. Suppose the rod A C to remain stationary, while B D rotates, the point P upon the latter moving with a velocity P G. The resultant motion of the pivot connecting the two sockets must have the direction P A, and its magnitude is determined by drawing G I perpendicular to P G. This resultant has a component of sliding along D B, represented by P H, equal to G I.

2. Next suppose D B stationary while A C rotates,

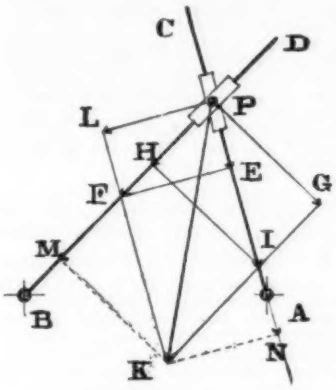


FIG. 7.

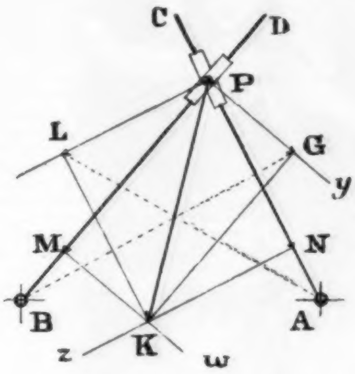


FIG. 8.

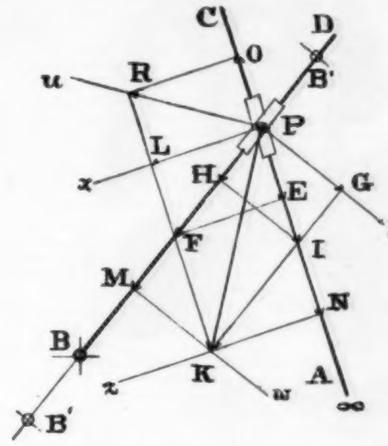


FIG. 9.

the point P upon that line receiving a motion P L. Then in a similar manner we find the resultant P F, and a sliding component P E, equal to L F, along C A.

3. Let both these rotations take place at once; then the final resultant motion P K of the pivot is found by compounding the partial resultants P I, P F.

4. From K let fall upon A C and B D the perpendiculars K N, K M; then I N = P E, and F M = P H. The total sliding along C A is equal to P I + P E, or P N; and that along D B is equal to P H + P F, or P M.

5. Consequently the intersection P, when the two rods turn at the same time as above indicated, is approaching A with a velocity P N, and approaching B with a velocity P M.

This may be presented from a different point of view, thus: in Fig. 8, which represents the same mechanical arrangement as that shown in Fig. 7, let the pivot P, connecting the two sockets, receive a motion represented by P K; then

1. Suppose the rod A C to be removed. In this case P K may be resolved into the components P G, P M; the first is one of rotation about B, the other is one of sliding along D B.

2. Suppose the rod B D to be removed; then P K = components P L, P N, of rotation about A, and of sliding along C A.

3. The mechanism admits of both rotations at once,

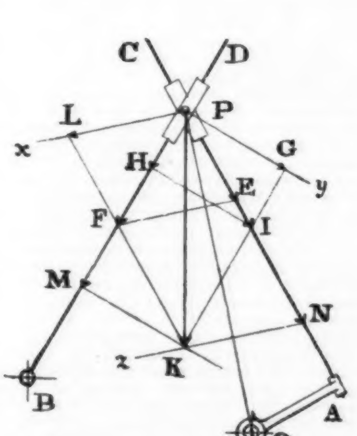


FIG. 10.

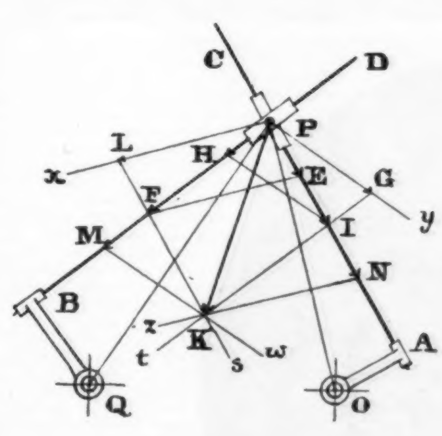


FIG. 11.

and also of the sliding along the rods. Hence when the intersection P has the motion P K, the rods will rotate with the angular velocities P A L, P B G, and the sockets will slide with the linear velocities P N, P M.

Again; if in Fig. 8 it be supposed that P shall approach A with a velocity P N, and also approach B with velocity P M: then P M is a sliding component, with which is to be compounded a motion, that *must* be one of rotation about B, and therefore has the direction P *y* perpendicular to B D. Consequently the resultant motion of P must be limited by M *w* parallel to P *y*. Similarly, this resultant must be limited by N *z*, perpendicular to A C; which cuts M *w* at K, thus determining the resultant motion of P. The nature of the mechanism is such that the pivot cannot approach A without a rotation of B D, nor approach B unless A C rotates; and each rotation, combined with the assigned sliding, must give the same resultant.

It is now to be noted that this investigation, thus presented in three different aspects with concordant results, is independent of the positions of the centers of motion. To illustrate: the line B D, in Fig. 9, might turn about any other point upon that line, as B' or B'', instead of about B. Such change would affect only the *angular* velocity, and the direction of the rotation, but would not affect either the resultant P K, or the sliding components P M, P N.

Let us then suppose the center A to be infinitely remote, and that while B D rotates about B, the rod A C has a motion of translation, in virtue of which the point P upon it shall move in the direction and with the velocity P R. Then P R = components P L, P O, of which the latter represents the sliding of the rod through the socket, and the former alone affects the intersection of the two rods. If then P G be the motion of P in rotation about B, the resultant P K is found as in previous cases, and has a component P N in the direction C A.

If on the other hand the components P M, P N, are assigned, the resultant P K is found by drawing M *w* perpendicular to P D, and N *z* perpendicular to A C, intersecting in K. Then P L is equal and parallel to N K; and if the direction P *u* of the translation of the rod A C is given, its velocity P R is ascertained by producing K L to cut P *u* in R.

Now if, in Fig. 6, we draw at M a perpendicular to P D, and at Q a perpendicular to P A, intersecting in T, we find P T, instead of P R, to be the true resultant motion of P under the assigned conditions: which incidentally corroborates the preceding analysis of the general problem, since in this case it can be geometrically demonstrated that P T is perpendicular to the radius P C, or in other words tangent, as it should be, to the circular path of T.

Thus far, the center about which each line rotates has been assumed to be a point lying on the line itself: evidently this is but a special case, and it has been first considered because the construction as well as the argument is thereby simplified. Now in Fig. 10, the center B still lies upon the rod B D, but the rod C A is rigidly secured to an arm A O, by which it is compelled to rotate about a center O.

The pivot P then, by virtue of its connection with one socket, can rotate about O, which will give it a motion in the direction P *x* perpendicular to P O, and can also move along the line C A; and its actual motion, whatever it may be, must be the resultant of components having these directions. And by virtue of its connection with the other socket, its actual motion must, as in the preceding cases, be the resultant of two components, one along the line D B, the other having the direction P *y* perpendicular to D B.

1. Suppose the rotation about B to be assigned, giving P on B D the velocity P G, the rod C A being stationary. The resultant will be P I, determined by drawing G I parallel to B D, and will have along B D a sliding component P H = G I.

2. Suppose B D stationary while the other rod rotates about O, giving P on C A the velocity P L. The resultant will have the direction D B, and the magnitude P F is determined by drawing L F parallel to C A; this resultant has a component P E, equal to L F, along C A.

3. If both rotations occur simultaneously, the final resultant P K is found by compounding the partial resultants P I, P F. Drawing K M perpendicular to B D, and K N perpendicular to P O, we have F M = P H, and I N = P E, and the sockets slide along the rods with the velocities P M, = P F + P H, and P N, = P I + P E.

4. If the resultant P K be assigned, it is now seen that it can be resolved into the components P M, P G, of sliding along B D and rotation about B, and also into the components P L perpendicular to P O, and P N along C A; the former representing the rotation about O, the latter the sliding on the rod.

5. If the sliding components P M, P N, are assigned, the resultant is determined by drawing M *w* perpendicular to B D, and N *z* perpendicular to P O; these intersect in K, and P K is the resultant.

Finally, in Fig. 11, the rod C A rotates about a center O and the rod B D about a center Q, neither center lying upon the rotating line. Without further explanation it will now be seen that P K must be not only the resultant of two components, P N along C A and P L perpendicular to P O, but also of two others, P M along D B and P G perpendicular to P Q. Consequently, if the sliding along the rods be assigned, K is determined by the intersection of M *w* perpendicular to P Q, with N *z* perpendicular to P O; and if the rotations are given, K is determined by drawing G *t* parallel to D B and L *s* parallel to C A. Should P G become zero, the rotation P L will give the resultant P F, with a sliding P H along C A; and so if P L = *o*, the resultant of the rotation P G will be P I, with a sliding P H along D B; P F and P I in these cases being simply the partial resultants, as obtained in the first mode of deduction by supposing each rod in its turn to remain at rest while the other one rotates.

Now referring again to Figs. 4 and 5, it will be seen that the true resultant P T is in the former much greater, and in the latter considerably less, than the value P R found by Mr. Heather's construction. But (as pointed out by Mr. J. H. Cuntz) this is due not to any general property of the conic sections, but to the circumstance that the angle M P Q is in one case obtuse and in the other acute. If, in Fig. 5, a semicircle be described upon A B as a diameter, it will cut the hyperbola in a point P', and the focal lines P'A, P'B, will be perpendicular to each other. At this point, then, Mr. Heather's construction is identical with the true one; this will also be the case at points determined in like manner upon the ellipse, if the circle cuts the curve at all; that is to say, if the minor axis be not greater than the distance between the foci; and the same is true of the parabola, as will be readily seen, at the extremity of the ordinate through the focus.

And in fact, following the hint thus given a little farther, it will appear that in each arrangement which has been considered there are certain points in which Mr. Heather's construction will give the correct result: in Figs. 4-9 inclusive this will be the case whenever P A is perpendicular to P B; in Fig. 10 we must have P B perpendicular to P O; and in Fig. 11 it is necessary that P B shall be perpendicular to P O and also that P A shall be perpendicular to P Q.

Roberval's method is equally applicable to the drawing of tangents to curves of double curvature, when the component motions of the given point are known; in the most complex case it would be necessary only to construct the parallelopipedon of which the three components are the adjacent edges, the resultant being the body diagonal passing through the given point, which is common to those three edges. But even this is not always necessary, as for instance in the case of the common helix; the circular motion is represented by a tangent to the transverse section of the cylinder, the linear advance by a line coinciding with the element which passes through the moving point; and a like construction suffices in drawing the tangent to the conical helix. For graphic operations, then, it would appear that no method could be devised that is so neat, so direct and so explicit as that of Roberval, which certainly does not require for its intelligent use any knowledge of the calculus, whether it is as Mr. Heather says, "implicitly comprehended in the processes" of that branch of mathematics or not. On the contrary, the physical conceptions of the composition of motion which it involves lie directly in the line of thought of the very ones least likely to resort to analytical reasoning. Whatever it may be in the abstract, it is in practice essentially a draughtsman's method, and as such deserves a more prominent place than it has been given.

Invention, a London scientific journal, says it has been discovered that the kola nut has the power to restore to normal condition the worst sufferer from intoxication or monomania.

PORTABLE ACCUMULATORS FOR STAGE EFFECTS.

MR. OSCAR BARRETT, the able and energetic manager of the Crystal Palace Theater, is one of the pioneers of electric lighting for stage purposes. As a result, a series of charming and beautiful effects have been produced.

A number of ladies in an exceedingly pretty ballet have been supplied with small lithanode accumulators and lamps. As shown in Fig. 1, the batteries are dropped into a small satchel which is securely fixed to the dress. Two silk-covered flexible wires serve to carry the current up to a small four-volt lamp, which

FIG. 1.—ELECTRIC HEAD DRESS—BACK VIEW.

FIG. 2.—ELECTRIC HEAD DRESS—FRONT VIEW.

is held by spring terminals. The battery used is small and compact, and weighs about a pound. The incandescent lamp is fixed in the center of a bright metal star with radiating arms, as represented in Fig. 2. Forked terminals fixed on the ends of the connecting wires serve to complete the circuit between lamp and battery, and these afford a method of instantaneously throwing the lamp in or out of action. The small glow lamp requires from 0·6 to 0·8 ampere and four volts to fully light it. Each cell has a capacity of 1·5 ampere hours, a capacity quite outside the maximum requirements of the performance. The battery consists of two cells, which are mounted in a thin metallic containing case.

A special feature in these batteries is the precaution taken to prevent any possibility of leakage of the electrolyte, the escape of which has unfortunately been the

FIG. 3.—ELECTRICAL EFFECT IN HOLLOW TREE.

great drawback to the employment of all forms of batteries for personal or stage decoration; and as a consequence, although 39 of these batteries have been used at each of the 100 performances given, no accident or damage of any kind arising from this cause has occurred.

Viewed from the front, the effect of the electric lamps is most charming. Each little lamp appears to emit rays much in the same way as a veritable star, and the light reflected from the bright metal background darts about in every direction. It seems almost incredible that such a brilliant effect can be produced from so minute a source of light. A casual onlooker would be inclined to judge the lamps as being from 3 c. p. to 4 c. p., but this enhanced effect is doubtless due to the contrast between the electric light, which is nearly white, and the yellow gas light which forms the background.

In addition to the light shown in Figs. 1 and 2, other novel electric effects have been introduced. In one of the scenes the indispensable "good fairy" is supposed to descend from the clouds to earth, and, being somewhat electrical, she naturally makes for the nearest and most prominent point, which in this case happens to be a hollow tree. In this piece of stage property the lady is supposed to secrete herself, and she ultimately emerges just in time to frustrate the designs of the wicked fairy. How to produce a halo around the fairy-like form while inclosed within the tree was a problem which could not readily be solved by the employment of the ordinary illuminants; but Mr. Barrett seems to have successfully overcome this difficulty by introducing the electric light. To this end a number of small incandescent lamps are fixed within the tree, and these, being backed by reflectors, cast their light upon the figure as soon as the current is switched on. This arrangement is shown in Fig. 3.

In the hut scene, which piece of apparatus is pushed bodily on to the stage, a glowing fire is represented. Under ordinary conditions the fire would be produced by gas jets, which are exceedingly unsafe and not altogether suitable. Here again, however, electricity is called in, and a few small glow lamps worked from a battery, which is fixed to the scenery and goes on with it, give the desired result.

From time to time during the summer months dramatic performances are given at the Crystal Palace. On the occasion of the visit of "Niobe" from the Strand Theater, the management were somewhat at a loss to produce the electrical sparking which is supposed to bring Niobe to life.

This difficulty, we are told, was soon overcome by utilizing some of the small lithanode cells to produce a flashing arc, which piece of apparatus was fixed at the base of the figure. Again, a similar effect was produced on the visit of Mr. Arthur Roberts with his "Two Lovely Black-Eyed Susans" company. In this case an electric lamp was placed in the lighthouse, and was made to appear and vanish at the will of Mr. Roberts, much to the amusement of the audience.

Doubtless the success of the lighting we have just described is due to the fact that the whole arrangement was placed in the hands of the Lithanode and General Electric Company, they on their part undertaking the recharging and maintenance at a stated charge per lamp per week.

We have probably said enough to show the enormous possibilities for both fixed and portable electric light when used for stage lighting. It certainly does seem somewhat strange that hitherto so very little should have been done in this direction. A light so safe and easily managed, and capable of so many applications, must surely supersede all others at no very distant period.—*Electrical Engineer.*

THE COHESIVE PROPERTY OF GOLD: ITS CHARACTER, VALUE, AND AVAILABILITY.*

By S. H. GUILFORD, D.D.S., Ph. D., Philadelphia, Pa.

GOLD is one of a small group of metals which from the earliest days of metallurgic science, or even of alchemy (which was unscientific experiment), have been designated "noble" metals. They received this appellation from the fact that, while they united more or less freely with other metals, they were very slow to combine with non-metallic substances, and hence were always found native or in a metallic state. But while thus found, gold at least is never found pure. Its most common associate is silver, although other metals, such as tellurium, bismuth, lead, etc., are often found in combination with it in minute quantities.

In this is constituted the difference between native gold and virgin gold; the former is always more or less alloyed as found, while the latter is gold that has been made pure by chemical action.

Gold, while possessing most of the physical characteristics common to metals, possesses certain ones in a very marked degree. Among these may be mentioned especially malleability and ductility. In the former it stands pre-eminent, while in the latter it is excelled by but one or two metals. Its possession of these two properties in so great a degree renders it useful above all other metals for dental manipulation, while its further property of insolubility in any of the pure acids, whether vegetable or mineral, makes it especially suitable to be placed in the human mouth.

Another property which it possesses to a remarkable extent is softness, although this is implied by the previously mentioned properties, for no metal could be malleable and ductile to the extent that gold is without being exceedingly soft.

Lead is softer than gold in that it retains its softness under continued beating, while gold, similarly treated, becomes stiff and hard; but gold is far more ductile than lead.

Malleability and ductility are in all cases due to and dependent upon cohesion, which may be defined as that force which binds and holds together the ultimate constituents or particles of any solid.

Gold in its pure state possesses this property to such an extent that two masses of it under suitable conditions may be as perfectly united in their cold state as they could be if fused by the aid of heat.

If two sheets of pure gold of moderate thickness, with perfectly clean surfaces, be laid one upon the other and passed between the rolls of a rolling mill, they will become so thoroughly united that no amount of force can separate them. The same result will take place between a sheet of pure gold and one of pure platinum under the same conditions. It is in this way that the crown metal so largely used to-day in the construction of crown and bridge work is produced.

So, too, in the process know as fiber plating, for the production of filaments from which gold lace is woven, a rod of silver is gilded by simply burnishing leaves of pure gold upon it. It is then drawn into wire so fine that a length of it extending a mile and a quarter will weigh but one ounce.

How is this perfect union brought about? Either one or two theories will account for it. One, the molecular theory, holds that while the attraction of cohesion operates upon all solid bodies, its operation is only sensible at insensible distances. When, therefore, the molecules of the same body, or of two similar bodies, are brought within the sphere of this attraction, cohesion takes place.

The other, which, for want of a better name, we may call the dynamic theory, holds that the molecules of a mass or masses of matter are held together by being interlocked with one another, either naturally or by being compelled to assume such a relation under the influence of pressure.

It would seem as though, in the instances cited, both the molecular and dynamic forces operated to produce the result, for union between the metals will not take place unless they are brought into the closest possible apposition, nor will it result if the metals have been hammered or rolled and not subsequently annealed. When a nugget or ingot of gold is subjected to pressure its bulk is rensibly reduced, but when heated to a point slightly below fusion its original dimensions are restored.

This latter process is known as annealing. So, also, when a mass of gold is beaten or rolled it assumes a condition of stiffness and intractability, but its original softness and plasticity are completely restored by annealing. These changes in the mass are explained by

* Read before the joint union meeting of the Pennsylvania and New Jersey State Dental Societies, July 21, 1892.—*Dental Cosmos.*

the universally conceded fact that, under the influence of pressure, the molecules are driven into closer proximity than is natural to them, and that heat, by expanding the mass, allows the particles to move slightly among themselves, and resume, as nearly as may be, their former relations to one another.

Gold, after being beaten into foil, is always annealed in order to restore to it the softness which has been lost in the process of hammering. It also restores its cohesiveness. When it is desired to modify this cohesiveness the foil is simply exposed to the air for a time, and thus converted into the quality known to us as semi-cohesive. During such exposure the gold probably attracts and attaches to itself minute particles of matter, which are always found floating in the air. It is also probable that there is a condensation upon its surface of certain adventitious gases and vapors. In this way the surface becomes coated with a layer of foreign substances which modifies, and would in time entirely destroy, its natural property of cohesion.

Some manufacturers of gold foil have a method of rendering it non-cohesive without exposure, and claim that, while in this condition it is as pure as the cohesive, it cannot, like other preparations of foil, be made cohesive by annealing.

The process of imparting this property to pure gold is kept a secret by the few who understand it. Truly non-cohesive gold possesses the quality of softness or pliability in a remarkable degree. This it could not have without the final annealing after beating, which, in restoring the softness, would also re-establish its cohesiveness. It is therefore reasonable to suppose that it is again deprived of its cohesiveness by some subsequent treatment that causes its surface to be overlaid with a film of such character as not to be readily dispelled or driven off by heat. Treating it with a solution of ferrous sulphate, or exposing it to the vapors of sulphur or phosphorus, would probably produce this result, but just what process is employed we cannot say. That the treatment employed in rendering foil non-cohesive is surface treatment is shown by the fact that when two superimposed sheets of this gold are cut through with a shears, the newly cut edges unite much in the same manner as cohesive gold.

The writer has seen a cavity filled with non-cohesive gold by pricking it in with two cambric needles set in wooden handles. The filling when completed was dense, and the layers of foil were so well united that they could not be separated. While nominally a non-cohesive filling, the layers were really held together by pure cohesion at the point where they were pricked, for the needle, in penetrating two or more layers at a time, exposed the central cohesive portion of the layers at the point of puncture, and brought them into direct contact, resulting in union. Further evidence that non-cohesive foil has had its peculiar property imparted to it by contamination with other metallic substances is furnished by melting in the flame of an alcohol lamp a rope of cohesive and one of non-cohesive foil. The globule resulting from the cohesive foil will be bright and clean, while that from the non-cohesive will be tarnished or oxidized, clearly showing the presence of extraneous matter.

I have here in small vials globules of gold obtained by melting ropes of foil in a Bunsen flame, and catching the globules upon a glass slab as they fell. It will be noticed that those labeled non-cohesive are of a decidedly darker or duller color than the others which were obtained from cohesive and semi-cohesive foil of various makes. One vial, marked "X, non-cohesive," contains globules obtained from a so-called non-cohesive gold; but this make of gold, while professedly non-cohesive, is not strictly so, because moderate heat readily imparts to it the cohesive quality. The globules in this case are nearly or quite as free from oxidation as those obtained from cohesive foil, showing little, if any, surface contamination.

Non-cohesive gold has for many years been sold and used under the less distinctive name of soft gold. The latter term, however, is a misnomer, for, as we have stated, all pure gold is soft unless this property has been interfered with by hammering or rolling. No foil can possibly be softer than cohesive foil, but the misuse of the term soft has arisen from the fact that in the manipulation of non-cohesive foil the layers will slide over one another without cohering, which seems to emphasize or exaggerate the impression of softness. The absence of this sliding or gliding quality in cohesive foil naturally but improperly suggests the idea of hardness. In large and accessible cavities, where no necessity exists for the sliding of gold upon gold, cohesive foil will be found to be equally as soft and tractable as the non-cohesive variety.

Each kind has its special advantages as well as its definite limitations of usefulness, and harm can only result in the ignorance or violation of the conditions under which each should be used.

The benefit conferred by the discovery of the availability of the cohesive property of gold foil in dental operations can scarcely be overestimated, for while the ravages of caries were checked in a very efficient manner by the use of non-cohesive foil, that higher and nobler fulfillment of our art in the perfect restoration of lost tissue could not have been obtained without the advantage of the cohesive property. By the former method, operations could only be performed in simple cavities, and where compound cavities presented, the chisel and file were called into requisition to reduce them to simple ones. In this way not only were the natural forms of the teeth destroyed, but the amount of masticating surface reduced and much discomfort entailed. With the cohesive property of foil intelligently employed, as it is to-day, all these disadvantages are removed and the liability to recurrence of decay greatly lessened.

The history of the development of cohesive gold filling has been similar to that of many other valuable methods and processes. At first its advantages alone were seen, and not only seen but exaggerated. A quality good in itself was naturally supposed to be good under every and all conditions, and its indiscriminate employment without recognition of its limitations resulted in many failures and brought it into disrepute.

The imperfect method of its manufacture and the unintelligent manner of its employment, due to ignorance of its peculiar properties and inexperience in its use, both combined to bring about the unfortunate results with which its earlier use was attended.

Each year, however, has witnessed improvement in quality as well as better methods and more suitable instruments for its manipulation, so that at the present time there are fewer failures attending its use, and little excuse for those that do occur.

Used with an intelligent recognition of its peculiar properties, and under conditions in harmony with them, it has become one of our most useful servants.

In considering its value and availability, it becomes necessary to notice certain practical points both in regard to its properties and manipulation.

The term cohesive, applied as it usually is in a general way, is not sufficiently distinctive to describe the different grades of this kind of foil in use to-day. As now manufactured, we have the moderately cohesive, better known as semi-cohesive; the regular or ordinary cohesive; and the extra cohesive, each differing from the others in important particulars. The former, for instance, would not be sufficiently cohesive to be used upon the surface, while the latter would be too intractable to be used anywhere but on the surface or in very large and exposed cavities.

For many years after its introduction cohesive foil was used in its most cohesive condition; in small cavities as well as large, in inaccessible as well as accessible ones, and at the base as well as the surface. Such use was in a large measure misuse, and the many failures that followed led in time to a better understanding of its limitations. Seeing that failure occurred where it only could occur in a cohesive filling, along the line of contact between gold and tooth substance, especially at the cervical margin, it was suggested, and came to be part of the practice with many, to line some part or all of the walls of the cavity with the more adaptable non-cohesive foil, and restrict the use of the cohesive to the body and surface of the filling. The combination of the two kinds of foil in this way, using each in accordance with its peculiar advantages, resulted in a great improvement in the quality of the work produced.

With but the two kinds of foil, the strictly cohesive and the strictly non-cohesive, to choose between, such combination of the two was most wise, and continues to be considered excellent practice. One difficulty attending the method was that of manipulation, for it required considerable skill to combine the two without disturbing their relative positions; while another was that in those cases where it might become necessary, cohesive gold could not be readily added by the welding process to the non-cohesive.

With the introduction of the semi-cohesive variety an advancement was made, for it possesses the ability to be adapted to any surface as thoroughly and accurately as the non-cohesive, and also to have the quality of cohesiveness imparted to it, when needed, by the application of slight heat. In this way the one variety of gold becomes available for use in place of two varieties.

While the manufacturer to-day produces cohesive foil of a far better quality than he did twenty years ago, it is still defective, as a rule, in that the annealing is carried to too great a degree, thus rendering the foil less tractable than it should be. For this reason the dentist who makes large use of cohesive foil generally prefers to buy that which is only slightly cohesive, and to render it more so, when desired, by annealing it himself at the time of using. Experience has shown that the quality of cohesiveness can be imparted to foil more delicately and with a wider range of degree by the dentist than the manufacturer, for he can vary it according to his needs.

There is a point in the process of annealing, well known to the experienced, which gives to the gold sufficient cohesiveness for all purposes without lessening its adaptability, whereas if carried beyond this point its best qualities are impaired. Careful and proper annealing, therefore, is one of the most important considerations in the manipulation of cohesive foil.

The extent to which annealing may be advantageously carried depends on the thickness of the foil and the manner in which it is to be applied. In the heaviest grades of rolled gold intended to be used upon or near the surface, or, for that matter, where the entire filling is to be made from it in large and very accessible cavities, the gold may be heated to a dull red color, and the greatest degree of cohesion thus imparted to it without interference with its working properties, for it is intended to be laid layer by layer in a comparatively even and regular manner.

With the lighter grades of foil, prepared in the form of twisted ropes or folded ribbons, for use in less exposed cavities and throughout the filling where the same evenness of surface cannot be maintained, so great a degree of annealing would seriously interfere with the proper working of the foil, without conferring any real advantage. It has therefore been found best to give to the lighter foil, which is used throughout the body of an ordinary filling, only a slight degree of cohesiveness, reserving the greater degree for surface work, where more perfect cohesion is required. The semi-cohesive variety of foil, which does not unite upon casual contact, but will allow one surface to glide over another without interference, and which only becomes united under pressure, is the kind best adapted for the main portion of all ordinary or medium sized fillings. When nearing the surface, the same gold slightly annealed will give to the filling that uniformity of texture and density so necessary to usefulness.

As to the manner of annealing foil, various practices prevail; some passing the foil through or near the naked flame, while others, preferring not to expose the gold thus to the products of combustion, heat it upon a tray of metal or mica held over the flame. The latter would seem to be the better way of avoiding overheating, but experience shows that equally good results follow the use of the former method, provided proper care be taken. To avoid overheating by this method with the lighter grade of foils, as well as to attain the proper degree of cohesiveness without harshness, the gold should never come in direct contact with the flame, but be passed quickly just above it. There seems to be no preference between the use of alcohol or illuminating gas for annealing, provided the latter is used in connection with a Bunsen burner, affording perfect combustion.

One interesting fact remains to be mentioned in connection with the subject of annealing. For years it has been generally claimed and believed that the so-called strictly non-cohesive variety of gold could not be rendered cohesive by annealing, but the writer has recently satisfied himself by experiment of the fallacy of the idea. Annealing it in an alcohol flame of moderate size does not materially change its quality of non-cohesiveness, but when heated to redness in the larger flame of a Bunsen burner its condition becomes so greatly changed that it can be as readily and perfectly welded as cohesive gold. Treated in this way, however, it differs from the ordinary cohesive gold in the fact that pieces coming into slight contact do not cohere, and that mallet force in some form is necessary to bring about the desired union.

Another very important feature to be considered is that of the form and character of the points used in the condensation of cohesive foil. If gold is torn or lacerated in the course of introduction, additional labor and time will have to be expended in again bringing the severed portions into absolute union. It is therefore the part of wisdom to avoid such severance. This can only be done by using points with the finest and most delicate serrations upon their surface, and that are free from any sharp angles. In addition to this, the face of the instrument should be of such size as to cover considerable surface, and thus avoid piercing the different layers. As we have already shown, cohesion takes place most readily and perfectly when the surfaces of the different layers are brought into absolute contact at all points. This is best accomplished by keeping the surface of the filling as nearly uniformly even as possible, and broad faced instruments should be used for this purpose.

Instrument points with just sufficient convexity to avoid flatness, and with distinctly rounded edges, will produce better results than any others in welding gold.

Fine serrations, while they are unobjectionable and produce good results in connection with slow malleting, where rapid malleting can be employed, as with the mechanical or electric mallet, even more perfect results are obtained by the use of smooth points, or those with but the faintest trace of roughness upon them. Points of this character, of as large size as can be conveniently employed, used in connection with cohesive gold of any form, will produce a filling so compact and homogeneous that it will never scale or pit, but always preserve the perfect surface given to it at the time of finishing. A filling of this character will have not only the appearance but the essential qualities of a mass of cast gold.

The pitting and scaling of cohesive foil fillings which have at times filled the heart of the ambitious young operator with dismay, and have been the cause of much of the opprobrium that has been cast upon the employment of cohesive gold, are attributable to one or more of three causes: too great cohesiveness of the gold; deep serrations and finely pointed instruments; and the use of foil so thin and delicate as to be readily torn and comminuted. Foil of greater tenuity than No. 4, as furnished under the names of corrugated, velvet, and the usual form of Wolrab gold, can only be safely manipulated in mass in the form of cylinders, mats, or rolls, and then only in connection with broad and finely serrated instruments, employed with the greatest care to prevent laceration.

The recent revival of the manufacture and use of the form of gold known as crystal, mat, or plastic gold calls for some notice of this variety before leaving our subject. The use of this form of gold for the filling of teeth dates back some thirty or forty years, and has from time to time found much favor with the profession. Its general use has not been continuous like that of foil, but it has periodically claimed attention and received recognition of its value according as some new process of manufacture or convenience of form has again brought it to the notice of the profession.

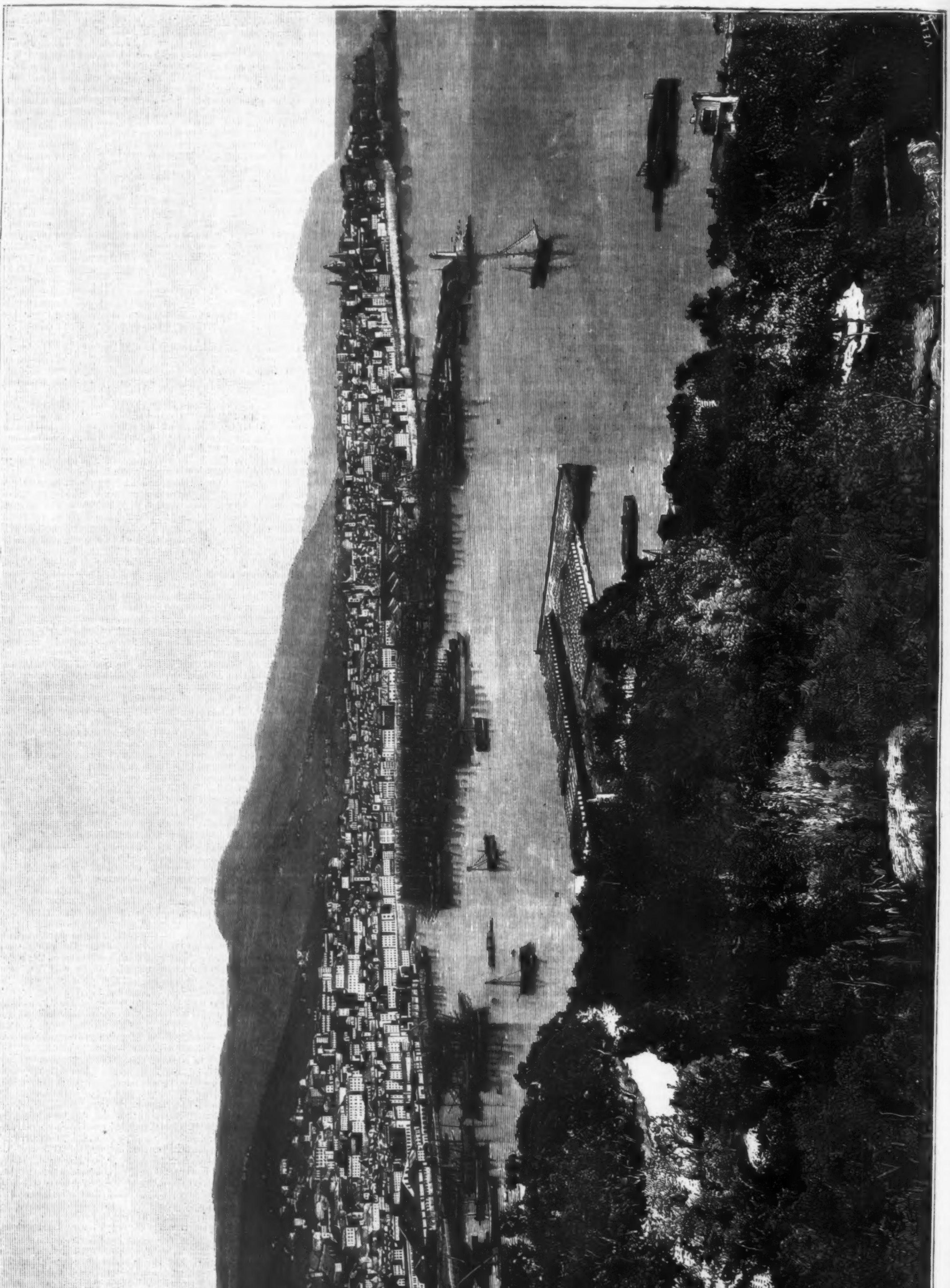
Gold thus prepared by a chemical decomposition and subsequent deposition, whether by the usual chemical processes or by electrolysis, appears as a brown powder, and consists entirely of a mass of crystals lightly interlocked. When in this condition, unlike crystalline masses of most metals, it is capable of being compressed into a perfectly solid and homogeneous mass without the aid of heat. Its purity, as well as its extreme cohesiveness and softness of texture, were naturally such as to commend it to our use for the filling of teeth. Such being the case, why has it failed to permanently hold its place among the forms of gold in general use? The answer is easily given. The very qualities which made it valuable led to its abuse. The ease with which it could be placed and packed in position, added to its extra cohesiveness, invited carelessness and led to failure.

Each generation of dentists has been fascinated by its attractive qualities, used it more or less extensively, met with failures, and abandoned it, only to have the same course repeated by the generation following. It has always possessed the good qualities attributed to it, and the best results have been and can be obtained with it when its peculiar properties are thoroughly understood, and when experience in its manipulation has led to overcoming the difficulties attending its use. In its loose and cohesive condition it is not only easily comminuted, but it also so readily coheres with similar masses upon mere contact that spaces are often unconsciously bridged over by it, and the resulting filling, though seemingly compact and homogeneous, is really more or less porous, and hence faulty.

On account of its extreme delicacy and tenderness, success in its use requires that it be most carefully handled and compacted with broad-faced instruments, and that mallet force for its further condensation be not applied until each piece has been well tamped into position by hand pressure. It is further necessary that each portion be carefully and exactly placed, for once in contact its cohesiveness will prevent even the slightest change.

To manipulate it according to these conditions requires the expenditure of more time and the exercise of greater care than any other form of gold, and for these reasons its use has from time to time been abandoned by the busy practitioner.

In conclusion, we may be allowed to express the opinion that, in spite of its many good qualities, its employment by the inexperienced is always attended



GENOA.—(From a Photograph.)

with danger, and that all in all, in a practical way, it possesses no advantage over the many other forms of cohesive gold now in use.

GENOA.

WE publish herewith a panoramic view of the city and harbor of Genoa, taken from a photograph.

Genoa the superb, as the Italians call the capital of ancient Liguria, is situated at the head of the famous Gulf of Genoa, and extends in a semicircle, like an immense amphitheater, from *Porta Pila*, which is about 19 ft. above the level of the sea, to the hills of *Porta di Chiappe y Graverolo*, at an altitude of more than 1,000 ft.

Its harbor is one of the best on the Mediterranean. It is twelve miles wide and is provided on the west with a gigantic lighthouse, near the new wharf, which is 380 ft. high and serves to guide vessels over the rough waters of the gulf. Its wharves, its ancient docks, and its fortifications cover a large area; its cathedral of the XI. century, and its churches, San Ambrosio, La Anunziata, San Esteban, Santa Maria di Carignano, Santa Maria di Consolazione, and others, are architectural monuments that are enriched by very fine paintings and sculpture by the best artists of the Renaissance; its palaces, the Ducal Palace and that of Andrea Doria, of Durazzo (the Royal Palace of to-day), of Pallavicini, of Adorno, of Spinola and many others, are celebrated all over the world.

In the middle ages the Genoese vessels that assisted the kings of Castile and Aragon in the conquests of Almeria and Tortosa, and other warlike enterprises, sailed from the port of Genoa. At Savona, the next town to Genoa, Columbus was born.—*La Ilustracion Española y Americana.*

THE TALL FLOWERS OF AUTUMN.

EACH season of the year has its own peculiarities in the outdoor garden, and it is the specialty of autumn to have tall plants, which having had two or three months of warm weather in which to make their growth begin in July and August to exhibit the full beauty of their flowers. Spring is gay with crocuses, hyacinths, tulips, and anemones, and, generally speaking, low-growing flowers, but now we are gathering from plants of our own height with flowers on a level with the eye. This gives no small amount of additional labor to the gardener, for unless our tall-growing border plants are well staked and secured, their beauty may easily be spoiled in one stormy night. Some things it is almost impossible to tie up properly; for instance, a bed of asters, peony flowered, which was gay and beautiful before the recent rains and wind, is now laid low. I do not know of any method of preventing such a mishap. It is simply impossible to tie hundreds of stems, and the great heads of bloom are so heavy that the rain quickly makes them nod and bend, and then fall low upon the ground. They will do still to gather, but the display of rich color coming from hundreds of asters of various shades from fine lilac to rich red and purest white is a thing of the past already.

I have been much pleased with lupines this year. Their great seeds grow readily without any trouble in the spring, and now the tall branching stems have lovely spikes of bloom, which have the additional advantage of being very sweet. The perennial kinds (L. polyphyllus) are over with me, though their long spikes of blue flowers lasted for some weeks, but L. mutabilis Cruickshanki is just in full beauty. Lupines are among our most common cottage garden plants, and therefore scarcely receive the attention they deserve. The variety of color on a spike of Cruickshanki is exceedingly pleasing to the eye. Why should it have such a dreadful name? The tall growth of this lupine only adds to its beauty when in a suitable place, for the spikes are brought well up to the level of the eye.

Among the numerous varieties of yellow composite flowers which come out in autumn, I think Rudbeckia Newmanni is still the best of all. It is crowded with its fine deep yellow blossoms, and the dark convex center of the flower gives it great beauty. This Rudbeckia will grow almost anywhere, provided always that it has plenty of water. It droops quickly under a blazing sun, but well watered it will do best in an open spot, and it is well worthy of it. Another beautiful flower of this kind, totally different in its mode of growth, because it grows tall and branching, whereas the Rudbeckia spreads itself about never more than two feet from the ground, is the so-called "miniature sunflower." It grows with me about six feet high, and goes on flowering throughout the autumn months. The center of the flower is nearly black and the leaves are small. For an autumn flower of this kind it is to be strongly recommended, it lasts so long when cut for the house, and has none of the coarseness which rather disfigures larger sunflowers. Now that harpaliums and heleniums are nearly gone, other flowers of the same type and form and color are most useful, both for the beauty of the border and also for making up large nosegays for the decoration of our rooms. On this account both R. Newmanni and the miniature sunflower are invaluable. The dark eye is always a pleasing feature in flowers of this kind. Unfortunately, the perennial Coreopsis, C. lanceolata, has not got it, and on this account it is far inferior to the annual plants of the same genus. Annuals give so much trouble in spring that, all other things being equal, we should naturally give the preference to the perennial species. But in this case, though C. lanceolata is well worthy of a place in the border because it is so prolific in producing its flowers, it will not bear comparison for a moment with Coreopsis (or Calliopsis, as it is more generally called) tinctoria or other annual kinds. As the latter are exceedingly hardy and easily grown, it is a pity not to find a place for them somewhere. The rich maroon brown of the petals of this plant is scarcely to be found elsewhere.

Galtonias do not seem to find much favor as we become more acquainted with them, and yet as autumnal flowers they are certainly handsome. The bulbs I bought last year are flowering well, but they have been constantly watered. Like many other bulbous-rooted plants, these things require to be attended to in the hot and dry months and to be well watered; and, after all, they are worth it. Their tall spikes of white bells contrast beautifully with the scarlet gladioli, which are in flower at the same time. This Galtonia or Hyacinthus candicans (I suppose some authority will settle in due time what its name ought to be) is said to be a shy bloomer; but with a little care, I do not think there need be much fear of not getting flowers.

Anemone Honorine Jobert is just now one of the most beautiful things in the border. It is a terrible weed, but one can forgive its weedy habit, which the poor call "wrastling," for the sake of its lovely white flowers, which are produced in such profusion. The earliest are the best, but for weeks this fine anemone is extremely beautiful. The red variety of Anemone japonica is not nearly so pretty as the Honorine Jobert, and its weedy habit is even more pertinacious, so that it becomes a troublesome thing when once admitted into the border.

The "tub garden" at this season is resplendent with magnificent agapanthus blooms. I have not got the white variety; it is not easy to find a good form of it. I saw it quite early this year at a Bath show, apparently a good variety, but not equal to the blue in length of tube. That may have been because it was so early.

I have been most pleased with Ricinus cambodgensis this year. Just now its dark purple foliage is very striking, and contrasts well with the pale green leaves of large-foliaged cannas. These cannas never flower with me, but the peculiar way in which their leaves unroll and the large soft green of their foliage when fully expanded make them interesting plants for the lawn. The flowering kinds, Crozy's hybrids, are also beautiful, but they have not done so well here out of doors as the large-foliaged cannas; still, their dark red leaves look

CRYPT OF THE ROYAL CHAPEL, GRANADA—SEPULCHERS OF FERDINAND AND ISABELLA.—(FROM A RECENT PHOTOGRAPH.)

CRYPT OF THE ROYAL CHAPEL, GRANADA.

THE ashes of the Catholic sovereigns do not rest in the sumptuous cenotaphs of the Royal Chapel. They repose in simple biers covered with rich tapestry in the crypt of the same chapel, in that crypt which the emperor Charles V. regarded as a "narrow sepulcher for the glory of his ancestors."

We have the pleasure of presenting to our readers a view of this crypt, which has been made from a photograph obtained by the Centro Artistic de Granada, and courteously sent to the director of this paper by order of the directors of that illustrious society. It is the first photograph ever made of this crypt, and to obtain it an illumination by magnesium lights of great power was necessary.

The central biers guard the remains of Donna Isabel and Don Fernando; those at the sides inclose the ashes of Donna Juana, *la Loca*, and her husband Don Felipe, *el Hermoso*. At the extreme end a small casket contains the body of the Prince of Asturias, Don Miguel, the two year old child who died at Granada in the year 1500.—*La Ilustracion Española.*

well in the border and their flowers are very pretty. Salpiglossis should not be forgotten among the tall-growing plants of this period of the year. Their marbled flowers are wonderfully varied in color and most beautiful, and by their side one good plant of the white tobacco (Nicotiana affinis) will scent a large space in the evening. Its scent is delicious out of doors, though almost too heavy for a room.

I do not believe that the old cactus Dahlia Juarezi has ever been equaled, much less excelled, by any more recent varieties. What I want to find is a white cactus dahlia equally good. I have not found one yet. Dahlias are no great favorities, but for many purposes they are useful and almost necessary at this time of the year. Gladioli are so soon over, and then some strong red flower is wanted. A pure white cactus dahlia would be almost equally useful if one could only come across a really good variety.

I think Eryngium amethystinum is one of the most beautiful of our autumn flowers. The color is unique and its habit lasting. The wild sea holly (Eryngium maritimum) is very pretty growing on sand hills by the seashore, but this garden species is undoubtedly one of the most beautiful of the plants which are to be found in our outdoor gardens.—*The Garden.*

THE FUTURE OF THE GUTTA-PERCHA SUPPLY.

By M. EUGENE SERULLAS.

AT a recent meeting of the French Societe d'Encouragement pour l'Industrie Nationale, M. Serullas, who had been commissioned by the society to make some investigations of the state of the world's production of gutta-percha, gave a summary of the results of his latest expedition, a report of which, translated from *L'Industrie Electrique*, follows:

After thanking the society for the pecuniary aid he had received, M. Serullas proceeded to deal with the practical results of his mission from the point of view interesting to the electrical industry. At a future meeting he will briefly review the whole of his researches in the Malay peninsula.

The situation with regard to the important question of the supply of gutta-percha was serious. It resulted, on one hand, from the treatment of the trees which furnished the gum so indispensable in submarine telegraphy and, on the other hand, to the rapidly increasing difference between the supply and the demand.

The method practiced by the natives for the extraction of the gutta consists in cutting down the tree, the new shoot of which, when it grows, does not yield gum until ten years old. When the tree (*Isonandra percha*) reaches the age of fifteen or sixteen years, the natives find the cutting of it scarcely remunerative. By felling all the trees anything like the right age which are met with, after having ruthlessly destroyed all the fully grown ones, the native has for many years prevented the reproduction and multiplication of this valuable plant.

In 1854, when gutta-percha was first introduced, many of the trees were already old; those which now survive are for the most part decayed, the repeated cuttings to which they have been subjected having doubtless diminished their longevity. There are still, however, half a dozen forests which the gutta-percha hunter, thinking by mistake exhausted, has forgotten, and in these propagation has been freely going on; but situated in districts which were the first to be opened to civilization and not of much value from the native's point of view, they have no particular interest except as forests.

The crisis dreaded, with reason, by manufacturers of submarine telegraph cables, is close at hand. It can only be avoided by systematic cultivation, and by methodically utilizing the last existing resources.

The work which M. Serullas has just accomplished will secure a sufficient supply for the future, by providing means of renewing dried-up sources, and starting plantations on a large scale in our colonies, and, thanks to a new process of extracting gutta from the trees, he bridges over the time necessary for these plantations to be of use.

By the existing method of obtaining gutta, the trees, when large and full grown, are cut and destroyed, and can only be of use again after many years of growth, but M. Yungfleisch, in May, 1888, suggested to M. Serullas a method of extracting gutta from the leaves.

The experiments made in Malay by this explorer have been conclusive as to the possibility of extracting the juice, coagulated and unchanged, from the tree, without sacrificing the trunk. The raw material which was brought to Paris has just been analyzed in the laboratory of M. Yungfleisch, under the direction and according to the advice of this expert. The results of this treatment by an entirely new process have been as decisive as unforeseen. Not only is the extraction of the gutta-percha from the leaves most economical, but the yield is enormous.

Any *Isonandra* tree possessed of leaves becomes, *ipso facto*, fit to be operated on. Without touching the trunk a proportion of pure gutta-percha can be obtained which, when dried, represents eight or nine per cent. of the weight of the raw material after desiccation in an oven at a temperature of 100° C. (212° F.) It therefore follows that young trees, as well as those which are so far decayed as to be useless under the native treatment, are capable of being very advantageously used, and a most satisfactory light is thrown on the question. So long as the solution of this matter possessed the characteristic of being a very long operation, it was condemned to be dealt with by the government; from now, however, private enterprise can step in. The plantations which will be started, and in which work the government takes the initiative, can be worked in a comparatively short time, and French capitalists will be able to find in the utilization of the last resources which exist in the Malay forests an investment which will return them some day or other large profits. The example provided by the culture of the *cinchona* in various foreign colonies is significant.

Would a French company promoted for such an enterprise be able to obtain, in the heart of the savage country of Malay, a sufficient quantity of raw material for immediate commercial and industrial operations? Certainly, because leaving aside the exaggerated figures which have been published relative to the importation of gutta-percha since 1843, and only taking into account those duly authenticated, one is bound to conclude that the number of trees still living amounts to over one million and a half. In fact, between 1843 and 1891, a period of forty-eight years, the electrical industry alone has consumed 10,360,000 pounds of gum, which can be proved to be *Isonandra percha*. By treating the felled trunk of a tree from twelve to fifteen years old, only three or four ounces of impure and wet gutta-percha can be obtained. It is impossible for a thirty-year-old tree to furnish more than nine ounces. At no period of its existence can a tree, if subjected to the native process, yield more than about a pound of gutta. After having yielded this maximum the tree dies away, and in a little time very little or no more juice can be obtained from the trunk; its whole life goes to the branches and leaves.

During forty-eight years one tree can only be cut four times. It must be remembered that in the neighborhood of Singapore, gutta-percha hunting was not started until about 1850. Taking it for granted that at the time of first cutting every tree was in a condition favorable for the maximum yield, it is evident that each one has not been able to furnish up to now more than 1 lb. + 4 oz. × 3 = 1 lb. 12 oz.; to produce 10,360,000 pounds has, therefore, required more than 5,600,000 distinct trees.

Local statistics and actual exportations all agree in confirming the statement of M. Serullas, to the effect that more than one-third of this number of trees is still in existence, that is to say, at least 1,850,000. These remaining trees, it is true, may not live very much longer, and their condition is such as to render them almost useless in the hands of the natives; but if an adult tree, in full vigor, can furnish without harm to it, and for a length of time, some 200 pounds of dried leaves, every six months an old tree should at least have enough foliage to furnish two-thirds of this amount. A young tree of four or five years old never gives less than about six pounds of dried leaves.

The leaves of a young tree, and of those recently cut down, are, curiously enough, larger and richer in gum than those of a large tree. The cutting of the branches, which at this age are few, seems in a short time to considerably increase their number. The trees easily lend themselves to grow as pollards. From a tree which to the native is valueless, *i. e.*, too old to permit of the usual treatment of the trunk, it is easy to gather a weight of leaves equivalent to eight and one-half pounds of gutta-percha; thus in a single day, by simply taking the leaves off such trees, five times as much gutta can be obtained as the natives could possibly secure by operations extending over half a century.

A young tree of four or five years old can, for its part, by simply picking its leaves, be made to yield some nine ounces of gum, that is to say, just about as much as a thirty-year-old tree is capable of furnishing when its trunk only is treated. On the whole, there are, without doubt, in the Malay forests more than 1,500,000 trees which will soon be permanently destroyed, and which, while of no value to the native, contain over 13,000,000 pounds of gutta-percha. Even supposing that the stripped leaves will not be replaced by new ones, there is still a very satisfactory margin, and the enterprise should be a safe one. Gutta-percha of first quality is worth in the market of Singapore about four shillings per pound, and this gum would lose in the process of purification ten or fifteen per cent. of its weight, which loss is represented by water and various impurities, such as sand, bark, etc. Under the present state of things, various commercial intermediaries make a profit which amounts to at least 3s. 4d. per lb., and adulterations are practiced in the most barefaced manner.

By treating the leaves of the *Isonandra percha*, a French company would be able to furnish from this date a large supply of gutta-percha for our electrical industry, of an excellent and homogeneous kind, and plantations destined to rescue our submarine telegraph industry from foreign monopoly will not have to be planted fifteen or sixteen years before they can be of use. Four years from the date of their planting each of the young trees will be worth as much in the hands of the European as an adult tree when left to the natives of Malay.

VERTIGO.

AT the recent meeting of the Medical Society of Virginia, held at Alleghany Springs, Va., the discussion on this subject was opened by Dr. E. T. Brady, of Marion. After remarking upon the nature of vertigo, in general, he stated that the causes were gastric, cardiac, cerebral, laryngeal, ocular, aural, toxic, epileptic, and essential. Larnygeal vertigo he regarded as another form of epilepsy, and believed that it would eventually be found that the toxic form was the most common. He believed that a far greater number of cases were attributable to nervous causes than to disturbance of the intra-cranial circulation. There are three causes that might affect the nerves, namely, *a*, the direct mechanical or chemical effect of poisons, or imperfectly oxidized materials accumulating in the blood; *b*, pressures upon centers governing the equilibrium; and, *c*, reflex from acute localized inflammations, the equilibrial centers being disturbed by unusual impressions caused by the deflection from associated nerve fibers. In speaking of the gastric form, he called attention to the fact that it was not accompanied with violent indigestion, but that digestion was prolonged or delayed. This he regarded as the most common form. He called attention to the fact that deaf mutes were free from vertigo, and seemed to infer from this that the sense of hearing enters largely into the causation of this condition. He omitted epileptic vertigo as being a form of epilepsy, and deserving a more detailed treatment than could be accorded it in such a limited space of time. He recommended cocaine locally in Meniere's disease, and suggested the advisability of producing deafness in obstinate cases.

Dr. William C. Dabney, of the University of Virginia, after remarking that vertigo is often due to toxic principles in the blood, recommended small doses of one-tenth grain of morphine, as affording temporary relief in some forms of renal vertigo especially. Of course the most important point in all these cases is to remove the cause.

Dr. Bedford Brown, of Alexandria, said that vertigo is not a disease, but rather the manifestation of disease, usually functional, sometimes organic, and then again of purely sympathetic origin. It may arise from morbid conditions of the circulation of the nervous system of the most opposite character. It often precedes death from post-partum or other uterine hemorrhage. Some of the most violent types of vertigo are associated with the hysterical state. Alcohol and tobacco are fruitful causes of vertigo, through their poisonous action on the brain and sympathetic system. Indigestion of a transient character and protracted dyspepsia, such as biliousness, causes sympathetic vertigo. Then we have an explosive form of vertigo due to blood poisoning, as seen during the progress of uræmia—coming and going in rapid succession. The therapy is as diverse as the causes are varied. Antiphlogistics, such as cathartics and a simple diet, are demanded when vertigo is associated with plethora or congestive tendencies. In cases of high arterial tension due to hypertrophy of the left ventricle, digitalis and nitro-glycerine are of use. Iron and strychnine almost invariably relieve cases associated with anæmia. Full doses of valerianate of ammonium and bromide of sodium give prompt results in the hysterical and nervous forms of vertigo. For the vertigo of Bright's disease, nitroglycerine ($\frac{1}{100}$ gr.) three times daily, with saline aperients and diuretics, are of service. Among the very best eliminant diuretics in these cases is diuretine or the salicylate of theobromine, in doses of two to five grains every two or three hours, in capsular form. In "bilious vertigo" acid fermentation and putrefactive action should be corrected by alkalies, and then hydrochloric acid, pepsin, strychnine, and bismuth subnitrate should be given. In nervous, feeble constitutions pills of valerianate of iron, quinine, and zinc produce admirable effects. When the tendency to vertigo is marked and persistent, the urine should be tested for albumen, casts, and sugar. The speaker had never seen a case of chronic nephritis or diabetes mellitus that was not accompanied with more or less vertigo.

Dr. Joseph White, of Richmond, remarked that aural vertigo accompanies such troubles of the ear as hyperæmia, anæmia, and apoplectiform troubles of the labyrinth (Meniere's disease), which are usually associated with corresponding alterations in the brain. Ophthalmic vertigo is due to lack of co-ordination of the ocular muscles. Nasal vertigo has been reported by a number of authors who assert that the intra-nasal changes by way of Meckel's ganglion cause localized vaso-motor alterations and anæmia in the brain. But Dr. White believed all such cases to belong to the category of "aural vertigo." Charcot first used the name laryngeal vertigo to designate laryngeal spasm followed immediately by vertigo and loss of consciousness. A patient in apparent health is suddenly seized with a mild tickling or irritation of the larynx, which produces a slight cough. Obscurity of vision and dizziness immediately follow, and he falls into a state of complete unconsciousness of only a few seconds' duration. Ordinarily there are no premonitory symptoms, and no assignable cause. In mild cases unconsciousness may not occur. The semblance to epilepsy is such that some observers style it "laryngeal epilepsy." The laryngeal cavity rarely presents evidence of lesion, although some cases have seemed to depend upon a catarrhal laryngitis.

Dr. Joseph Price, of Philadelphia, remarked upon some cases of vertigo following prolonged hemorrhage, as in tubal pregnancy, neglected polypi, etc.—*Med. Record.*

REMOVING THE VERMIFORM APPENDIX.

MODERN surgery finds its great field of application and development in our large hospitals. Each institution has, distinct from its other departments, a highly organized surgical division, in which most skillful treatment for the patient and widest opportunities for the surgeon are combined.

The operators are appointed by the hospital authorities, and are known as visiting surgeons. They are always men of experience and reputation, whose devotion to their work has prompted acceptance of the place, for no remuneration is thereto attached. But, on the other hand, the patient pays nothing for the operation and subsequent treatment, so that in the end the arrangement is only one of mutual advantage. Moreover, for the outside medical world there is an advantage also, because the work of the surgeon is not always a matter of privacy, and once a week the hospital announces a public surgical clinic.

For the benefit of the uninformed, a surgical clinic may be said to be a public operation at which the surgeon explains to the observers all his proceedings. Yet in fact it is both more and less than this. For not one, but usually three operations, are successfully performed on clinic day, and while called public, physicians and medical students only are invited and expected to attend.

In one of the largest hospitals in New York City the surgical clinic is held on Saturday afternoons. The visiting surgeon previously decides, on account of urgency or interest, what patients he will then operate upon, and announcements in medical phraseology of those cases are sent out to certain friends of the operator and to medical institutions. If the operations are dangerous or new, a large attendance is sure to follow. Indeed, often the importance of the surgeon's work can be estimated by the size of his audience.

The preparations for clinic day are left to the house surgeon, his assistants, the nurses, and attendants. The patients are fortified by rest and dieting for the severe shock and reaction, the operating room is furnished anew with towels, sponges, and dressings, the instruments are selected and cleaned. For all the work connected with the operating room the house staff is directly responsible, and under their watchful eyes must be carried out the careful, detailed regulations of modern antiseptic surgery. The duty of attending to the patients falls principally to the nurses. For a certain time previous to the operation their diet must be regulated, and even prohibited as the appointed hour approaches. Yet their strength must be at the same time maintained. And after all, one feels that it is really a Divine Providence which nerves them. What a strain on mortal powers must it be to lie for hours with sickness and even death beside one, anticipating an operation from which you may wake up in the next world, or, if in this, only to tarry for a day!

The operating room of the hospital herein referred to,

the Roosevelt, is on the second floor of a small rear wing on the main building. The visitor approaches it through numerous small doors, turnings, and staircases, and at last finds himself in a most curious little theater. A small pit, or arena, occupies the center of the room. It is circular, of about twelve feet in diameter, and contains, besides the operating table, all surgical requisites methodically and conveniently arranged, for method and convenience conduce to speed and accuracy, two things of vital importance in an operation. From this circle rise four rows of benches, so narrow that they seem almost Liliputian. They are for the audience, and on one side of this tiny "orchestra circle" is a small stairway leading to a gallery where four more circles of seats are ranged. But they are disposed more steeply, so that the occupants can gaze directly downward upon the prostrate patient. Though at first this all seems ridiculously small and uncomfortable for the observers, its convenience is soon apparent, as every step of the proceedings can be plainly seen, and as far as discomfort is concerned, that is forgotten in the interest aroused.

The character of the audience at this clinic is noteworthy. Nearly every man plainly belongs to the medical profession. Young and old sit side by side, and with only a look of absorbed interest watch the surgeon ply his knife. Every face is thoughtful and serious. The personality of the patient is never considered. Each sees only the operation, and that the patient is present is a fact of only secondary importance. Sometimes one or two venturesome members of the laity slip in, attracted by the novelty of the affair, but it usually happens that these gentlemen hasten away with pale, perspiring countenances before the surgeon is half through his work.

A few minutes before 2:30 P. M. a shrill whistle sounds throughout the hospital halls. This announces the arrival of the visiting surgeon. The hearts of at least three sufferers beat faster at that signal, for on his steady nerve and wise skill depend their lives this afternoon. What a responsibility for one man! What a terrible trust is the implicit confidence those patients place in him!

As the whistle sounds, all is bustle and activity among attendants and doctors. The first patient, accompanied by an orderly and nurse, is brought on a wheel bed to the door of the operating room. Here they wait until the house surgeon orders the etherization to begin. Within a dressing room the visiting surgeon, his assistants, and the house staff are busy putting on long white gowns and scrubbing carefully hands and arms. While this is being done a glance at the equipment of the operating room is necessary in order to understand the later proceedings.

In the center of the small circular pit is the operating table. It is made of stout oak, and is covered with cushioned leather. Underneath are many levers and hinges, so that the head or legs of the patient can be inclined to any desired position. At first it seems comfortable enough for everyday use, but the average observer would surely prefer as an article of furniture a table without such associations as this one inevitably possesses. On each side of the arena, against a fencing that marks the limit for visitors, are ranged shelves and tables, neatly stacked with all surgical requisites. On the right are rows of large bottle jars, marked with the figures $\frac{1}{1000}$ and $\frac{1}{5000}$. They are full of solutions, in those strengths, of the bichloride of mercury, the great antiseptic of modern surgery. This chemical figures everywhere. All instruments, every towel and sponge, the hands and arms of the operators, and the wound in the patient's body, are continually kept wet with it in the course of the operation. Everything, in fact, that comes in contact with the open wound must be made antiseptic with the bichloride of mercury. If this were not rigidly adhered to, the best efforts of the surgeon would be defeated. Countless germs would enter the wound and cause an inflammatory process which would effectually prevent healing, and probably cost the patient his life.

Further along on the shelves are tall piles of folded towels. These are soaked with the same antiseptic liquid. At the beginning of the operation they are spread out over the patient's body around the seat of operation, and as fast as blood soils the vicinity of the wound fresh ones are placed over them. Thus every effort is made to preserve cleanliness and health around the surgeon's incision. Near the end of the shelves are kept the bandages, gauzes, and cotton for dressing the wounds. They are neatly piled, and of such snowy whiteness that when they cover up some especially ugly wound a certain medicinal charm seems to reside in their spotless purity.

A main feature of the room is on the other side. This feature is the instruments. In a very large, flat dish, filled with bichloride solution, they rest, unconscious of what agents they are for human life and death. In one corner are the artery clamps, each of which looks like a pair of scissors, except that their points are broad and blunt, so as easily to grasp a bleeding vessel. Beside them are the knives of many different shapes. Each one glitters brightly, but the person not conversant with surgical matters is surprised at the small size of the blade. Many imagine that surgeons' knives are the size of butchers' tools, whereas all surgical work, with the exception of amputations at the thick part of the legs, is done with blades as small as those of the average penknife. The other instruments comprise bone cutters, saws, probes, forceps, and scissors. All have undergone a certain course of treatment calculated by the house surgeon to destroy any microbes that might have taken residence upon them. This treatment consisted of vigorous boiling for a protracted length of time. Then, to preserve their cleanliness, they are kept in the antiseptic solution until the end of the operation.

The last thing to be observed before the patient is brought in is a tall, white iron table holding several glass boxes. These boxes are heavily made and contain the inevitable bichloride solution. Soaking continually there are kept numerous spools of catgut and silk of all sizes, so arranged that they can be unwound without being handled. As fast as needed in the operation sutures for sewing the wounds and ligatures for tying the arteries are cut off and handed to the surgeon. On the same table are the needles and needle holders. The former are of curious, bent shapes, some only slightly curved, and others forming a complete semicircle. Straight needles are sometimes used, but the curved ones are indispensable for sewing in deep and difficult places.

When all preparations are finished, the surgeon, his assistants, and the house staff enter the operating room. All are clad in white gowns tied around the waist, and the hands and arms of each man almost shine from scrubbing. Each religiously soaks his hands in a bowl of bichloride water. Then the visiting surgeon, who for the afternoon is commander-in-chief, informs the audience in regard to the first operation. He gives the history of the patient, the present symptoms, and his own diagnosis. The visitor learns thereby that the patient is a man 36 years of age, who has enjoyed good health up to two years ago. Since that time, the surgeon states, he has had numerous severe attacks of pain in the right side of the abdomen, each of which lasted for some days, and was accompanied by fever and other constitutional symptoms. The increasing severity of the attacks brought him to the hospital, and then the surgeon gives the result of his diagnosis—"plainly a case of appendicitis," or an inflammation of that small rudimentary appendage to the intestines situated in the right side of the abdomen. In the same calm manner he gives his reasons for operating and the results he hopes to obtain. His operation will be to cut down into the abdominal cavity and remove with the knife the diseased organ. That will strike at the root of the trouble. There is little or no hope without an operation; but with one the odds are greatly in favor of perfect recovery.

"Is the patient ready?" he quietly asks the house surgeon. An affirmative answer is given. "Have him brought in." And then the operator goes again to wash his hands.

A pair of folding doors is thrown open and a nurse, an orderly, and the anæsthesist enter with the patient. He is taken from the wheel bed and placed on the table. The doctor whose duty it is to administer the ether has begun his work some minutes before, and the patient is in a state of profound unconsciousness. The face is deeply flushed and the veins of the neck bulge out, the breathing is violent and loud, coughing comes on at times; everything indicates to the visitor that the patient is almost choked to death. If sensation were present, such would certainly be the feeling, but so quickly does unconsciousness supervene that the discomforts of the anæsthetic are soon unnoticed. Yet before that state is reached the patient experiences a terrible suffocation and choking. The ether fills his lungs fully, and he struggles for air. Then the anæsthesist raises the ether bag and admits enough oxygen to quiet the strugglings, after which he continues the administration stronger than ever. Within five to eight minutes the patient's limbs relax, and insensibility supervenes. All his nerves of sensation and voluntary action are paralyzed; only those of involuntary action can convey impulses. How fortunate here that the heart and lungs are controlled by nerves of the latter class, else ether were useless.

When the insensible form is laid on the operating table, the anæsthesist takes a seat at the head and continually administers the ether. He must watch the breathing and keep a finger on the pulse. By their action he must judge of how much ether to give, and to a great degree does the patient's safety depend on him, for sometimes death has resulted from the anæsthetic. Ether, however, is much safer than chloroform, though more troublesome, and in the hands of an experienced man its dangerous effects are minimized.

Meanwhile the house surgeon and other members of the staff, with the attendants, prepare actively for operating. The blankets are removed and rubber sheets placed beneath the body, the patient's abdomen is washed and scrubbed, and wet towels are thrown over so as to leave exposed only the seat of the operation. The nurse takes position where she can wash the soiled sponges in bichloride water, and replace them fresh in the bowl at the surgeon's elbow. And here it may be said that although no one does less at an operation than the nurse, her presence always diffuses an indescribable sense of security and gentleness throughout the room. All else is so terribly business like and so different from a sick room at home that a part of the danger seems dispelled; and this effect is heightened when the small I. H. N. cross of the King's Daughters, which so many nurses wear, catches the observer's eye.

The head surgeon and his assistants advance to the table. A small glittering knife, forceps, and several artery clamps are placed beside them. The surgeon takes the scalpel, and the assistants are ready with sponges and clamps to follow up his work. He feels the diseased part for a moment, then with a quick glance confirming his intentions, firmly draws the knife through the skin for a distance of six inches. Like an opened purse the skin separates behind the keen blade. Another stroke, and a layer of muscle is divided. Some vessels are cut through and blood flows freely, but with dexterous hands the assistants sponge it away and apply the artery clamps. Carefully does the surgeon proceed when he next cuts, for each stroke brings him nearer to the internal organs. At last the knife exposes the peritoneum. This is a smooth, delicate membrane lining the abdominal cavity. It is extremely liable to inflammation, and when in that state constitutes the dread disease of peritonitis. Before the discovery of trustworthy antiseptics it was almost sure death to cut through it, but that is done now by good surgeons with perfect safety.

By this time the wound is so deep that the assistants must hold open the walls with retractors while the surgeon divides the layer of peritoneum. He does this guiding his knife with another instrument, called a director, so that he will not accidently wound the bulging intestines. This being successfully accomplished, the clamped arteries and veins are tied with ligatures of catgut which the ready assistant holds at the surgeon's elbow. As fast as a vessel is secured the clamp is removed, and the wound soon appears unencumbered and free from bleeding.

Fresh towels are then spread around the wound, and the surgeon's hands once more are washed. He draws open the walls of the long deep cut, and peers into the cavity. The snake-like viscera crowd over and obscure close examination. A search with the hand is necessary to find the beginning of the large intestine, at the rear of which is attached the notorious *appendix vermiformis*. The surgeon runs over coil after coil of the small intestine. It is alive and warm, and, protruding from the wound, rests on the surface of the body. Everything is terribly still. Only the stertorous breathing of the patient breaks the silence. Suddenly, for the first time since he began to cut, the surgeon speaks. "Here it is," he says. He raises the dark red extremity of the larger organ, and sees coiled on its posterior surface a worm-shaped object about four inches in length and of the thickness of a lead pencil. With skillful fingers its attachments are torn away until it hangs only by its root. What a small, insignificant part of our anatomy, but what a source of human ill!

The surgeon then calls for a catgut ligature, which he ties tightly around the root, close to the wall of the intestine. This effectually closes any opening which may have existed, from the appendix into that organ. The necessity of so doing is apparent at the operator's next step. Carefully and surely he severs with his scissors the diseased member just beyond the ligature, and then a breath of relief seems to rise from every one present. The radical part of the operation is over.

As soon as the appendix is off, an attendant hands the surgeon a cautery. This is a blunt steel rod kept at a red heat by an ingenious arrangement of a tiny bellows and alcohol lamp. With this instrument the operator burns the root of the appendix left on the intestine, so as to form a scab over the raw surface. It sizzles and smokes under the heat.

The surgeon rests for a few minutes at this point. Attendants apply hot cloths to the exposed organs and clean the vicinity of the wound, while he washes his blood-covered hands. But soon all is ready to close and bandage the wound, for every moment saved here in the retreating is clear advantage for the patient. The sufferer shows plainly the effect of the prolonged etherization. Although his breathing is quiet, it is not powerful and vigorous as at first, and the face is not heavily flushed, but very pale. The anæsthesist remarks that the pulse is good, and the surgeons hasten that the ether may be stopped. They carefully wash the intestines so roughly handled and also the walls of the wound. A call for sutures is then made and immediately responded to. Firmly the extremities of the wound are stitched, both below at the peritoneum and above at the skin, but the central part of the wound is left open from top to bottom. The surgeon informs the assembly that this is a precautionary measure, for it may be that some serious inflammatory process will occur deep in the wound around the intestine. If everything were tightly closed by stitching, such danger could not be discovered and warded off. Therefore the conservative method of first insuring healthy healing at the bottom of the wound is adopted.

After the few stitches have been made a small rubber tube is inserted and cotton gauze impregnated with iodoform is packed down the opening for its entire depth. The tube is left in the wound for some days, and serves to drain off into the outer dressings all fluid exudations. The iodoform is a soothing antiseptic and admirably adapted to promote quick healing. The entire surface of the wound is then covered with thin rubber gauze, which is non-adhesive and prevents the dressings sticking to the raw edges of the skin. Upon this are spread many folds of the softest cotton gauze, and over them layers of snow-white absorbent cotton wool. The ether having been discontinued already, the patient is raised and quick hands wind the broad bandages over and over the entire abdomen. Few things are more interesting to admirers of skill than the bandaging of a good surgeon, for every stroke is masterly and rapid, every turn firm and smooth. The finished dressing has a symmetry very pleasing to the eye, and what is of more importance, will never slip.

As soon as the last bandage is pinned the surgeons retire to prepare for the next operation. The patient is placed once more on the wheel bed, the house surgeon gives instructions to the nurse, the doors are thrown open, and the sufferer is taken to the ward, there to recover consciousness and demonstrate the success or failure of the operation.—*N. Y. Sun.*

DAY OF THE WEEK OF ANY GIVEN DATE.

For Sixty Centuries.

RATIOS FOR CENTURIES.

4	2	0	5	4	2	0	5	4	2	0	5
*	100	200	300	2000	2100	2200	2300	4000	4100	4200	4300
400	500	600	700	2400	2500	2600	2700	4400	4500	4600	4700
800	900	1000	1100	2800	2900	3000	3100	4800	4900	5000	5100
1200	1300	1400	1500	3200	3300	3400	3500	5200	5300	5400	5500
1600	1700	1800	1900	3600	3700	3800	3900	5600	5700	5800	5900

*The years 1 to 99, inclusive.

RATIOS OF MONTHS.

January	3	April	2	September	1
" Leap Year	2	May	4	October	3
February	6	June	0	November	6
" Leap Year	5	July	2	December	1
March	6	August	5		

RULE.—Of the figures denoting the year, strike off those occupying the place of units and tens, to this number add its one-fourth part, (disregarding the remainder if any) the day of the month the ratio for the century and the ratio for the month. Divide the sum by 7 and the *remainder* will denote the day of the week.

If the remainder be 1 the day denoted is Sunday
" " " 2 " " Monday.
" " " 3 " " Tuesday
" " " 4 " " Wednesday
" " " 5 " " Thursday
" " " 6 " " Friday
If there be no remainder " " Saturday

EXAMPLE 1.—Upon what day of the week did Columbus discover America?

Solution.—Date........October 12, 14 | 92
One fourth of 92........ 23
Day of month........... 12
Ratio for century 1400.. 0
Ratio for month of Oct.. 3
Ratio for Old Style Date 2
Divide by.................7) 132
18—6 remainder, denoting that the day of the week was Friday.

EXAMPLE 2.—Upon what day of the week was George Washington born?

Solution.—Date...... February 22, 17 | 32
One fourth of 32........ 8
Day of the month....... 22
Ratio for century 1700 3
Ratio for month of Feb 6
Divide by.................7) 69
9—6 remainder, denoting that the day of the week was Friday.

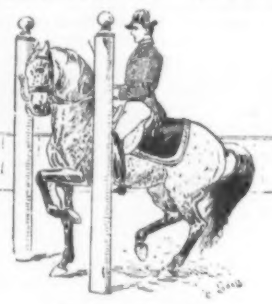
THE OLD AND NEW STYLE.

A year is the time required for the revolution of the earth around the sun, viz. 365 days 5 hours 48 minutes, and 49 7-10 seconds. To include the fraction of a day Julius Cæsar decreed that every fourth year should consist of 366 days. This is the Julian or Old Style, and is an excess for each year of 11 minutes, and 10 3-10 seconds, so that in 1582 there had been an over-reckoning of ten days. To correct this the 5th of October of that year was reckoned the 15th. Still there was an overplus amounting in a century to 18 hours, 37 minutes and 10 seconds so it was agreed that every centurial year that was not divisible by 400 should not be a leap year. This is the Gregorian or New Style, and was adopted by an act of the British Parliament, September 3, 1752. The difference between the New and Old Style is *twelve days*. The dates of some of the events previous to that year of that century (the date of Washington's birth, for example) were changed to accord with the New Style. In using the above rule regarding dates of events previous to 1752, care must be used as to what style they belong.

TRAINING OF HORSES.

The artificial gaits of saddle horses are simply natural gaits improved by an increased freedom in the movement of the shoulders and greater flexibility of the joints, especially those of the hind quarters. A distinction is usually made between military and school-trained horses, and hunting and racing horses, as the latter receive their training out of doors, not in a riding school. The requirements of a military horse are a good temper, an easy mouth, obedience, speed, willingness to turn to either side or to stop and turn on its haunches suddenly, quickness in starting, familiarity with firing, music and flags, in fact, fear of nothing. On the other hand, a horse trained in a school must be proficient in the acquired gaits by which the riding masters try to improve the natural gait. This teaching comprises maneuvers of two kinds, the first including those in which the horse does not lift his feet any higher than in his natural gait, and the second those in which both fore feet or all of the feet are raised from the ground simultaneously. In this article we will confine ourselves to an explanation, by means of pictures with short descriptions, of the chief lessons in this fancy training, beginning with maneuvers of the first class referred to above, which are as follows:

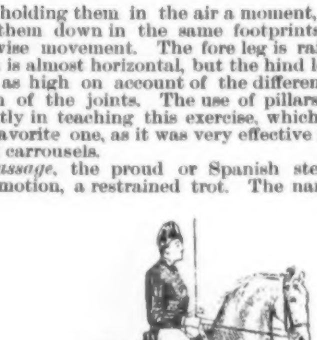
The *piaffe* is the trot without movement, the animal lifting diagonally opposite feet simultaneously, as in



THE PIAFFE.

trotting, holding them in the air a moment, and then putting them down in the same footprints, without any sidewise movement. The fore leg is raised until the thigh is almost horizontal, but the hind leg cannot be raised as high on account of the difference in the formation of the joints. The use of pillars or posts aids greatly in teaching this exercise, which was formerly a favorite one, as it was very effective in processions and carrousels.

The *passage*, the proud or Spanish step, is the *piaffe* in motion, a restrained trot. The name comes

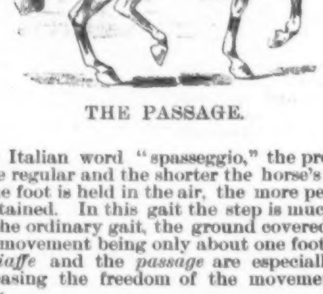


THE PASSAGE.

from the Italian word "spasseggio," the promenade. The more regular and the shorter the horse's step, the longer the foot is held in the air, the more perfect the result obtained. In this gait the step is much shorter than in the ordinary gait, the ground covered by each forward movement being only about one foot.

The *piaffe* and the *passage* are especially useful for increasing the freedom of the movement of the shoulders.

The *galoppade*, or the fancy gallop, is a maneuver in which the horse holds itself under restraint, with



THE GALOPPADE.

the joints very much bent, the separate movement of each foot being perceptible, so that four time can be counted, while in the military gallop only three time is heard, because in the latter the off fore foot and the nigh hind foot are moved simultaneously.

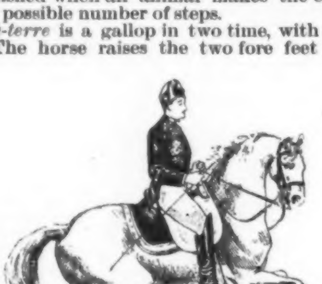
The *passade* is a maneuver in which the rider guides his horse along a wall of a road, turns with a half volt, and returns along the same line. If he then turns again with a half volt to ride a third time over the same line, this second turning is called a *repassade*. Any gait can be employed in a passade. If the gallop is used, a distinction is made between the slow and the quick passade. In the slow passade the rider must keep his horse well gathered up and moving in regular, slow time, both on the straight line and in the half volt, while in the quick passade the animal covers about half of the straight line with a short, restrained gallop, but from there is allowed to run as he can to the point where he gathers himself up again for a short gallop in order to be ready for the half volt.

In a *pirouette* the horse turns in a circle, the diameter of which is nearly equal to the length of his body,

THE PIROUETTE.

one hind foot serving as the turning point around which he moves. In this exercise the number of steps taken by the hind feet must equal those taken by the fore feet. If a horse could make the entire circle without touching his fore feet to the ground, that would be an ideal pirouette, but it would be very difficult to find a horse that could do that, and so a master is entirely satisfied when an animal makes the circle with the least possible number of steps.

Terre-à-terre is a gallop in two time, with two hoof beats. The horse raises the two fore feet together,



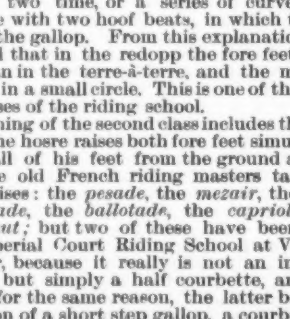
THE TERRE-A-TERRE.

putting them down again simultaneously, the hind feet following in almost the same manner, so that as the animal moves along he rises only a little from the ground in a series of little springs forward and sidewise. Although the terre-à-terre belongs rightfully to the maneuvers of the first class, because the horse raises its feet such a short distance from the ground, it is really the foundation for the maneuvers of the second class, for, according to the rule, all jumps should be made in two time, as the terre-à-terre is.

The *redopp* is closely related to the terre-à-terre. When rightfully performed this is a fancy or school gallop in two time, or a series of curvettes, in a small circle with two hoof beats, in which the feet are held as in the gallop. From this explanation it will be understood that in the redopp the fore feet are raised higher than in the terre-à-terre, and the maneuver is performed in a small circle. This is one of the most difficult exercises of the riding school.

The training of the second class includes those lessons in which the hosre raises both fore feet simultaneously, or raises all of his feet from the ground at the same time. The old French riding masters taught seven such exercises: the *pesade*, the *mezair*, the *courbette*, the *croupade*, the *ballotade*, the *capriole*, and the *pas-et-le-saut*; but two of these have been excluded by the Imperial Court Riding School at Vienna, viz., the mezair, because it really is not an independent maneuver, but simply a half courbette, and the pas-et-le-saut, for the same reason, the latter being only a combination of a short step gallop, a courbette and a capriole. These exercises had also been rejected by La Guérinière, because he declared that old, used-up horses performed it of their own accord, to gather strength for a capriole.

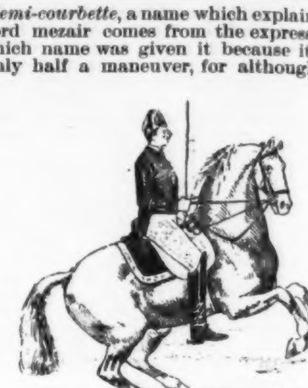
The *pesade* is the raising of the fore part of the body, with the fore legs drawn under, to such a height that



THE PESADE.

the line of the back will form an angle of 45° with the ground. The body of the rider must in this, as in all of the maneuvers, be held perpendicular to the surface of the ground. The pesade requires that the fore part of the body should be raised higher from the ground than in any of the other exercises, and at the same time affords an opportunity for practicing the different springs or jumps.

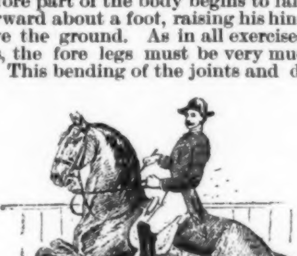
The *mezair*, which, as above stated, is no longer treated as a separate maneuver, was formerly called also a *demi-courbette*, a name which explains its nature. The word mezair comes from the expression "moitie air," which name was given it because it was considered only half a maneuver, for although the horse



THE MEZAIR.

raises himself higher than in the terre-à-terre, still it is not as high as in the courbette.

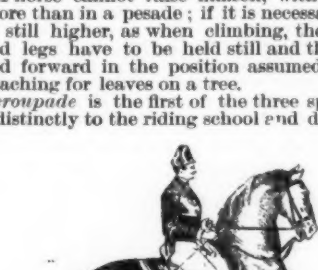
The *courbette* is a jump or spring in which the legs are very much bent, but the fore part of the body is not raised as high as in the pesade, and at the moment when the fore part of the body begins to fall the horse springs forward about a foot, raising his hind legs very little above the ground. As in all exercises of the second class, the fore legs must be very much bent at the knee. This bending of the joints and drawing of



THE COURBETTE.

the legs close under the body form the characteristic feature of all properly executed maneuvers of this class. A horse cannot raise himself, with his knees bent, more than in a pesade; if it is necessary to raise himself still higher, as when climbing, the joints of the hind legs have to be held still and the fore legs stretched forward in the position assumed by a goat when reaching for leaves on a tree.

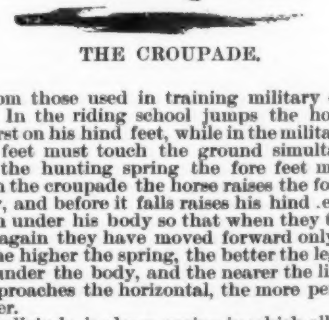
The *croupade* is the first of the three springs that belong distinctly to the riding school and differ mate-



THE CROUPADE.

rially from those used in training military or racing horses. In the riding school jumps the horse must alight first on his hind feet, while in the military spring all four feet must touch the ground simultaneously, and in the hunting spring the fore feet must land first. In the croupade the horse raises the fore part of his body, and before it falls raises his hind feet, drawing them under his body so that when they touch the ground again they have moved forward only about a foot. The higher the spring, the better the legs can be drawn under the body, and the nearer the line of the back approaches the horizontal, the more perfect the maneuver.

The *ballotade* is also a spring in which all the feet are raised, and in which the position of the fore legs is



THE BALLOTADE.

almost the same as that of the hind legs. In exercise the horse does not draw his hind legs under him, but raises them so that the shoes show at the rear as if ready for a blow. As there is no means of making a

horse understand what position of the pastern joint is desired during a spring, it is beyond the power of the master to teach an animal any particular spring. He can only teach him that one to which he seems most inclined when practicing between the pillars or posts. If the horse draws his legs under his body, the croupade must be cultivated; if he shows his shoes as if ready to strike, the ballotade must be practiced. It will, therefore, be understood that it is impossible to teach one and the same horse both of these maneuvers, so that at a certain signal he will execute one, and at another signal the other.

The *capriole* is the highest and the most complete of the riding school springs. When the horse has raised

THE CAPRIOLE.

his fore and hind feet equally high and his back is almost horizontal, he thrusts his hind legs out with all the power at his command, as if he would tear himself apart.

From the foregoing it will be understood that the three riding school springs are distinguished from one another only by the positions of the hind legs; in the croupade they are drawn under the animal's body, in the ballotade he raises his hind feet so that the shoes are shown as if ready for a blow, and in the capriole the hind feet are thrown out.—*Der Stein der Weisen.*

ABERRATION PROBLEMS.*

EVERYBODY knows that, to shoot a bird on the wing, you must aim in front of it. Every one will readily admit that to hit a squatting rabbit from a moving train you must aim behind it.

These are examples of what may be called "aberration" from the sender's point of view, from the point of view of the source. And the aberration, or needful divergence between the point aimed at and the thing hit, has opposite sign in the two cases—the case when receiver is moving and the case when source is moving. Hence, if both be moving, it is possible for the two aberrations to neutralize each other. So to hit a rabbit running alongside the train, you must aim straight at it.

If there were no air, that is all simple enough. But every rifleman knows to his cost that though he fixes both himself and his target tightly to the ground, so as to destroy all aberration proper, yet a current of air is very competent to introduce a kind of spurious aberration of its own, which may be called windage; and that he must not aim at the target if he wants to hit it, but must aim a little in the eye of the wind.

So much from the shooter's point of view. Now attend to the point of view of the target.

Consider it made of soft enough material to be completely penetrated by the bullet, leaving a longish hole wherever struck. A person behind the target, whom we may call a marker, by applying his eye to the hole immediately after a hit, may be able to look through it at the shooter, and thereby to spot the successful man. I know that this is not precisely the function of an ordinary marker, but it is more complete than his ordinary function. All he does usually is to signal an impersonal hit; some one else has to record the identity of the shooter. I am rather assuming a volley of shots, and that the marker has to allocate the hits to their respective sources by means of the holes made in the target.

Well, will he do it correctly? assuming of course that he can do so if everything is stationary, and ignoring all curvature of path, whether vertical or horizontal curvature.

If you think it over, you will perceive that a wind will not prevent his doing it correctly; the line of hole will point to the shooter along the path of his bullet, though it will not point along his line of aim. Also, if the shots are fired from a moving ship, the line of hole in a stationary target will point to the position the gun occupied at the instant the shot was fired, though it may have moved since then. In neither of these cases (moving medium and moving source) will there be any aberration error.

But if the *target* is in motion, on an armored train for instance, then the marker will be at fault. The hole will not point to the man who fired the shot, but to an individual ahead of him. The source will appear to be displaced in the direction of the observer's motion. This is common aberration. It is the simplest thing in the world. The easiest illustration of it is that when you run through a vertical shower, you tilt your umbrella forward; or, if you have not got one, the drops hit you in the face; more accurately, your face as you run forward hits the drops. So the shower appears to come from a cloud ahead of you, instead of from one overhead.

We have thus three motions to consider: that of the source, of the receiver, and of the medium; and of these, only motion of receiver is able to cause an aberrational error in fixing the position of the source.

So far we have attended to the case of projectiles, with the object of leading up to light. But light does not consist of projectiles, it consists of waves; and with waves matters are a little different. Waves crawl through a medium at their own definite pace; they cannot be *flung* forward or sideways by a moving source; they do not move by reason of an initial momentum which they are gradually expending, as shots do; their motion is more analogous to that of a bird or other self-propelling animal than it is to that of a shot. The motion of a wave in a moving medium may be likened to that of a rowing boat on a river. It crawls forward with the water, and it drifts with the water; its resultant motion is compounded of the two, but it has nothing to do with the motion of its source. A shot from a passing steamer retains the motion of the steamer as well as that given it by the powder. It is projected, therefore, in a slant direction. A boat lowered from the side of a passing steamer, and rowing off, retains none of the motion of its source; it is not projected, it is self-propelled. That is like the case of a wave.

The diagram illustrates the difference. Fig. 1 shows a moving cannon or machine gun, moving with the

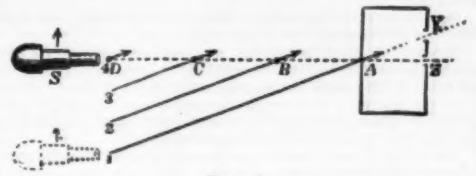


FIG. 1.

arrow, and firing a succession of shots which share the motion of the cannon as well as their own, and so travel slant. The shot fired from position 1 has reached A, that fired from position 2 has reached B, and that fired from position 3 has reached C by the time the fourth shot is fired at D. The line, A B C D, is a prolongation of the axis of the gun; it is the line of aim, but it is not the line of fire; all the shots are traveling aslant this line, as shown by the arrows. There are thus two directions to be distinguished. There is the row of successive shots and there is the path of any one shot. These two directions inclose an angle. It may be called an aberration angle, because it is due to the motion of the source, but it need not give rise to any aberration. True direction may still be perceived from the point of view of the receiver.

Attend to the target. The first shot is supposed to be entering at A, and if the target is stationary, will leave it at Y. A marker looking along Y A will see the position whence the shot was fired. This may be likened to a stationary observer looking at a moving star. He sees it where and as it was when the light started on its long journey. He does not see its present position, but there is no reason why he should. He does not see its physical state or anything as it is now. There is no aberration caused by motion of source.

But now let the receiver be moving at same pace as the gun, as when two grappled ships are firing into each other. The motion of the target carries the point, Y, forward, and the shot, A, leaves it at Z, because Z is carried to where Y was. So in that case the marker looking along Z A will see the gun, not as it was when firing, but as it is at the present moment; and he will see likewise the row of shots making straight for him. This is like an observer looking at a terrestrial object. Motion of the earth does not disturb ordinary vision.

Fig. 2 shows as nearly the same sort of thing as possible for the case of emitted waves. The tube is a

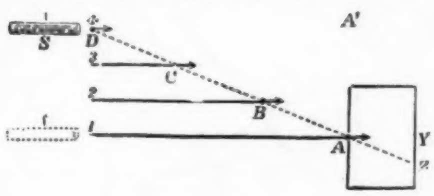


FIG. 2.

source emitting a succession of disturbances without momentum. A B C D may be thought of as horizontally flying birds, or as crests of waves; or they may even be thought of as bullets, if the gun stands still every time it fires, and only moves between whiles.

The line A B C D is now neither the line of fire nor the line of aim; it is simply the locus of disturbances emitted from the successive positions 1 2 3 4.

A stationary target will be penetrated in the direction, A Y, and this line will point out the correct position of the source when the received disturbance started. If the target moves, a disturbance entering at A may leave it at Z, or at any other point according to its rate of motion; the line, Z A, does not point to the source, and so there will be aberration when the target moves. Otherwise there would be none.

Now Fig. 2 also represents a parallel beam of light traveling from a moving source, and entering a telescope or the eye of an observer. The beam lies along A B C D, but this is not the direction of vision. The direction of vision to a stationary observer is determined not by the locus of successive waves, but by the path of each wave. A ray may be defined as the path of a labeled disturbance. The line of vision is Y A 1, and coincides with the line of aim; which in the projectile case (Fig. 1) it did not.

The case of a revolving lighthouse, emitting long parallel beams of light and brandishing them rapidly round, is rather interesting. Fig. 3 may assist the

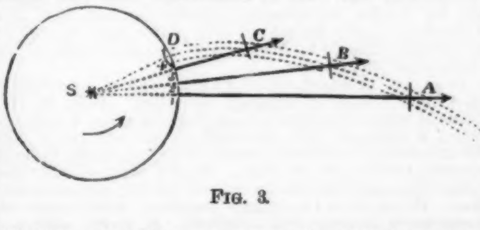


FIG. 3.

thinking out of this case. Successive disturbances, A, B, C, D, lie along a spiral curve, the spiral of Archimedes; and this is the shape of the beams as seen illuminating the dust particles, though the pitch of the spiral is too gigantic to be distinguished from a straight line. At first sight it might seem as if an eye looking along those curved beams would see the lighthouse slightly out of its true position, but it is not so. The true rays or actual paths of each disturbance are truly radial; they do not coincide with the apparent beam. An eye looking at the source will not look tangentially along A S, and will see the source in its true position. It would be otherwise for the case of projectiles from a revolving turret.

Thus neither translation of star nor rotation of sun can affect direction. There is no aberration so long as the receiver is stationary.

But what about a wind, or streaming of the medium past source and receiver, both stationary? Look at Fig. 1 again. Suppose a row of stationary cannon firing shots, which get blown by a cross wind along the slant, 1 A Y (neglecting the curvature of path which would really exist): still the hole in the target fixes the gun's true position, the marker looking along Y A sees the gun which fired the shot. There is no true deviation from the point of view of the receiver, although the shots are blown aside and the target is not hit by the particular gun aimed at it. With a moving cannon, combined with an opposing wind, Fig. 1 would become very like Fig. 2.

(N. B.—The actual case, even without complication of spinning, etc., but merely with the curved path caused by steady wind pressure, is not so simple, and there would really be an aberration or apparent displacement of the source toward the wind's eye: an apparent exaggeration of the effect of wind as shown in the diagram.)

In Fig. 2 the result of a wind is much the same, though the details are rather different. The medium is supposed to be drifting down across the field opposite to the arrows. The source is stationary at S. The arrows show the direction of waves *in the medium;* the dotted slant line shows their resultant direction. A wave center drifts from D to 1 in the same time as the disturbance reaches A, traveling down the slant line, D A. The angle between dotted and full lines is the angle between ray and wave movement. Now, *if the motion of the medium inside the receiver is the same as it is outside,* the wave will pass straight on along the slant to Z, and the true direction of the source is fixed. But if the medium inside the target or telescope is stationary, the wave will cease to drift as soon as it gets inside, under cover as it were; it will proceed along the path it has been really pursuing *in the medium* all the time, and make its exit at Y. In this latter case, of different motion of the medium inside and outside the telescope, the apparent direction, such as Y A, is not the true direction of the source. *The ray is, in fact, bent where it enters the differently moving medium* (as shown in Fig. 4).

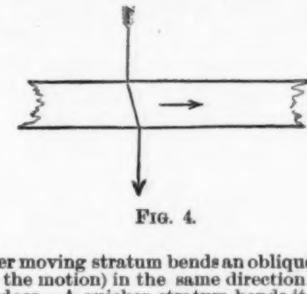


FIG. 4.

A slower moving stratum bends an oblique ray (slanting with the motion) in the same direction as a denser medium does. A quicker stratum bends it oppositely. If a medium is both denser and quicker moving, it is possible for the two bendings to be equal and opposite, and thus for a ray to go on straight. Parenthetically I may say that this is precisely what happens, on Fresnel's theory, down the axis of a water-filled telescope exposed to the general terrestrial ether drift.

In a moving medium waves do not advance in their normal direction, they advance slantways. The direction of their advance is properly called a ray. The ray does not coincide with the wave normal in a moving medium.

All this is well shown in Fig. 5.

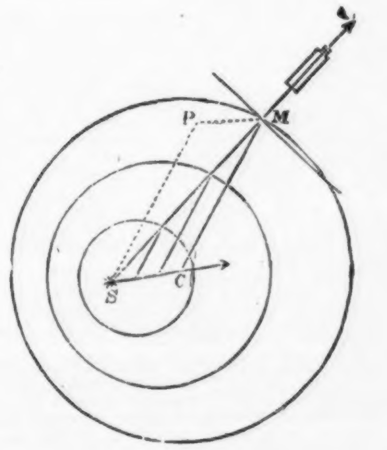


FIG. 5.

S is a stationary source emitting successive waves, which drift as spheres to the right. The wave which has reached M has its center at C, and C M is its normal; but the disturbance, M, has really traveled along S M, which is therefore the ray. It has advanced as a wave from S to P, and has drifted from P to M. Disturbances subsequently emitted are found along the ray, precisely as in Fig 2. A stationary telescope receiving the light will point straight at S. A mirror, M, intended to reflect the light straight back must be set normal to the ray, not tangential to the wave front.

The diagram also equally represents the case of a moving source in a stationary medium. The source, starting at C, has moved to S, emitting waves as it went, which waves as emitted spread out as simple spheres from the then position of source as center.

* A lecture on "The Motion of the Ether near the Earth," by Dr. Oliver Lodge, at the Royal Institution, Friday evening, April 1, 1892.—*Nature.*

Wave normal and ray now coincide: S M is not a ray, but only the locus of successive disturbances. A stationary telescope will look, not at S, but along M C to the point where the source was when it emitted the wave, M; a moving telescope, if moving at same rate as source, will look at S. Hence S M is sometimes called the *apparent* ray. The angle, S M C, is the aberration angle

Fig. 6 shows normal reflection for the case of a moving source. The mirror, M, reflects light received from

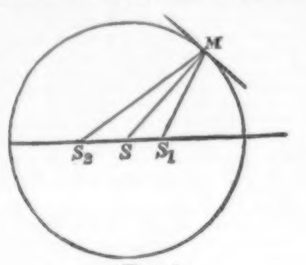


FIG. 6.

S_1 to a point, S_2, just in time to catch the source there, as it travels steadily to the left.

Parenthetically I may say that the time taken on the double journey, S_1MS_2, is not quite the same as the double journey, SMS, when all is stationary, and that this is the principle of Michelson's great experiment referred to below.

For the rest of the lecture I am going to call the medium which conveys light, "ether" simply. Every one knows that ether is the light-conveying medium, however little else they know about the properties of that tremendously important material.

We have arrived at this: that a uniform ether stream all through space causes no aberration, no error in fixing direction. It blows the waves along, but it does not disturb the line of vision.

Stellar aberration exists, but it depends on motion of observer only. Ethereal motion has no effect upon it, and when the observer is stationary with respect to object, as he is when using a terrestrial telescope, there is no aberration at all.

Surveying operations are not rendered the least inaccurate by the existence of a universal ethereal drift; and they therefore afford no means of detecting it.

But observe that everything depends on the ethereal motion being uniform everywhere, inside as well as outside the telescope, and along the whole path of the ray. If stationary anywhere, it must be stationary altogether. There must be no boundary between stationary and moving ether, no plane of slip, no quicker motion even in some regions than in others. For (referring back to the remarks preceding Fig. 4) if the ether in receiver is stagnant while outside it is moving, a wave which has advanced and drifted as far as the telescope will cease to drift as soon as it gets inside, but will advance simply along the wave normal; and in general at the boundary of any such change of motion a ray will be bent, and an observer looking along the ray will see the source not in its true position, not even in the apparent position appropriate to his own motion, but lagging behind that position.

Such an aberration as this, a lag or negative aberration, has never yet been observed; but if there is any slip between layers of ether, if the earth carries any ether with it, or if the ether, being in motion at all, is not equally in motion everywhere throughout every transparent substance, then such a lag or negative aberration must occur; in precise proportion to the amount of the carriage of ether by moving bodies.

On the other hand, if the ether behaves as a perfectly frictionless inviscid fluid, or if for any other reason there is no rub between it and moving matter, so that the earth carries no ether with it at all, then all rays will be straight, aberration will have its simple and well known value, and we shall be living in a virtual ether stream of 19 miles a second, by reason of the orbital motion of the earth.

It may be difficult to imagine that a great mass like the earth can rush at this tremendous pace through a medium without disturbing it. It is not possible for an ordinary sphere in an ordinary fluid. At the surface of such a sphere there is a viscous drag, and a spinning motion diffuses out thence through the fluid, so that the energy of the moving body is gradually dissipated. The persistence of terrestrial and planetary motions shows that ethereal viscosity, if existent, is small; or at least that the amount of energy thus got rid of is a very small fraction of the whole. But there is nothing to show that an appreciable layer of ether may not adhere to the earth and travel with it, even though the force acting on it be but small.

This, then, is the question before us:

Does the earth drag some ether with it? or does it slip through the ether with perfect freedom? (Never mind the earth's atmosphere: the part it plays is not important.)

In other words, is the ether wholly or partially stagnant* near the earth, or is it streaming past us with the opposite of the full terrestrial velocity of 19 miles a second? Surely if we are living in an ether stream of this rapidity, we ought to be able to detect some evidence of its existence.

It is not so easy a thing to detect as you would imagine. We have seen that it produces no deviation or error in direction. Neither does it cause any change of color or Doppler effect; that is, no shift of lines in spectrum. No steady wind can affect pitch, simply because it cannot blow waves to your ear more quickly than they are emitted. It hurries them along, but it lengthens them in the same proportion, and the result is that they arrive at the proper frequency. The precise effects of motion on pitch are summarized in the following table:

Changes of Frequency due to Motion.

Source approaching shortens waves.
Receiver approaching alters relative velocity.

* The word "stationary" is ambiguous. I propose to use "stagnant" as meaning stationary with respect to the earth, *i. e.*, as opposed to stationary in space.

Medium flowing alters both wave length and velocity in exactly compensatory manner.

What other phenomena may possibly result from motion? Here is a list:

Phenomena Resulting from Motion.

(1) Change or apparent change in direction; observed by telescope, and called aberration.

(2) Change or apparent change in frequency; observed by spectroscope, and called Doppler effect.

(3) Change or apparent change in time of journey; observed by lag of phase or shift of interference fringes.

(4) Change or apparent change in intensity; observed by energy received by thermopile.

Motion of either source or receiver can alter frequency, motion of receiver can alter apparent direction, motion of the medium can do neither; but surely it can hurry a wave so as to make it arrive out of phase with another wave arriving by a different path, and thus produce or modify interference effects.

Or again it may carry the waves down stream more plentifully than up stream, and thus act on a pair of thermopiles, arranged fore and aft at equal distances from a source, with unequal intensity.

And again, perhaps the laws of reflection and refraction in a moving medium are not the same as they are if it be at rest. Then, moreover, there is double refraction, colors of thin plates and thick plates, polarization angle, rotation of the plane of polarization; all sorts of optical phenomena.

It may be, perhaps, that in empty space the effect of an ether drift is difficult to detect, but will not the presence of dense matter make it easier? Consider No. 3 of the phenomena tabulated above.

I expect that every one here understands interference, but I may just briefly say that two similar sets of waves "interfere" whenever and wherever the crests of one set coincide with and obliterate the troughs of the other set. Light advances in any given direction when crests in that direction are able to remain crests, and troughs to remain troughs. But if we contrive to split a beam of light into two halves, to send them round by different paths, and make them meet again, there is no guarantee that crest will meet crest and trough trough; it may be just the other way in some places, and wherever that opposition of phase occurs there will be local obliteration or "interference." Two reunited half beams of light may thus produce local stripes of darkness, and these stripes are called interference bands.

If I can, I will produce actual interference of light on the screen, but the experiment is a difficult one to make visible at a distance, partly because the stripes or bands of darkness are usually very narrow. I have not seen it attempted before. [Very visible bands were formed on screen by three mirrors, one of them semi-transparent, arranged as in Fig. 7.]

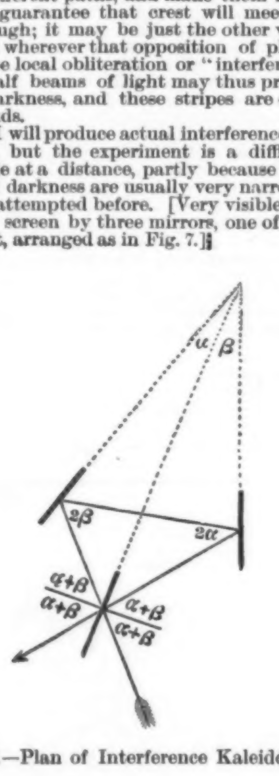


FIG. 7.—Plan of Interference Kaleidoscope.

Now a most interesting and important, and I think now well known, experiment of Fizeau proves quite simply and definitely that if light be sent along a stream of water, traveling inside the water as a transparent medium, it will go quicker with the current than against it. You may say that is only natural; a wind helps sound along one way and retards it the opposite way. Yes; but then sound travels in air, and wind is a bodily transfer of air; hence, of course, it gives the sound a ride; whereas light does not really travel in water, but always in ether. It is by no means obvious whether a stream of water can help or hinder it. Experiment decides, however, and answers in the affirmative. It helps it along with just about half the speed of the water, not with the whole speed, which is curious and important, and really means that the moving water has no effect whatever on the ether of space, though it would take too long to make clear how this comes about. Suffice for present purposes the fact that the velocity of light inside moving water, and therefore presumably inside all transparent matter, is altered by motion of that matter.

Does not this fact afford an easy way of detecting a motion of the earth through the ether? Here on the table is water traveling along nineteen miles a second. Send a beam of light through it one way and it will be hurried; its velocity, instead of being 140,000 miles a second, will be 140,009 miles. Send a beam of light the other way, and its velocity will be 139,991; just as much less. Bring these two beams together; surely some of their wave lengths will interfere. M. Hoek, astronomer at Utrecht, tried the experiment in this very form; here is a diagram of his apparatus (Fig. 8). Babinet had tried another form of the experiment previously. Hoek expected to see interference bands, from the two half beams which had traversed the water, one in the direction of the earth's motion and the other against it. But no interference bands were seen. The experiment gave a negative result.

An experiment, however, in which nothing is seen is never a very satisfactory form of a negative experiment; it is as Mascart calls it, "doubly negative," and we require some guarantee that the condition was

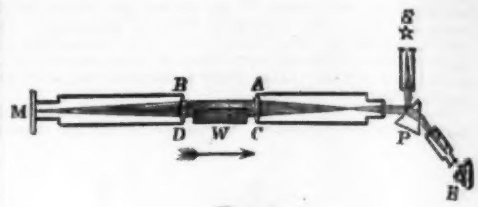


FIG. 8.

right for seeing what might really have been in some sort there. Hence Mascart and Jamin's modification of the experiment is preferable (Fig. 9). The thing now looked for is a shift of already existing interference bands, when the above apparatus is turned so as

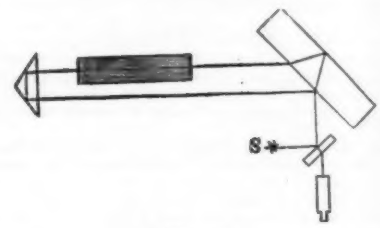


FIG. 9.

to have different aspects with respect to the earth's motion; but no shift was seen.

Interference methods all fail to display any trace of relative motion between earth and ether.

Try other phenomena then. Try refraction. The index of refraction of glass is known to depend on the ratio of the speed of light outside to the speed inside the glass. If then the ether be streaming through glass, the velocity of light will be different inside it, according as it travels with the stream or against it, and so the index of refraction will be different. Arago was the first to try this experiment, by placing an achromatic prism in front of a telescope on a mural circle, and observing the deviation it produced on stars.

Observe that it was an *achromatic* prism, treating all wave lengths alike; he looked at the *deviated* image of a star, not at its *dispersed* image or spectrum, or else he might have detected the change of frequency effect due to motion of source or receiver first actually seen by Dr. Huggins. I do not think he would have seen it, because I do not suppose his arrangements were delicate enough for that very small effect; but there is no error in the conception of his experiment, as Professor Mascart has inadvertently suggested there was.

Then Maxwell repeated the attempt in a much more powerful manner, a method with could have detected a very minute effect indeed, and Mascart has also repeated it in a simple form. All are absolutely negative.

Well, what about aberration? If one look through a moving stratum, say a spinning glass disk, there ought to be a shift caused by the motion (see Fig. 4). The experiment has not been tried, but I entertain no doubt about its result, though a high speed and considerable thickness of glass or other medium is necessary to produce even a microscopic apparent displacement of objects seen through it.

But the speed of the earth is available, and the whole length of a telescope tube may be filled with water; surely that is enough to displace rays of light appreciably.

Sir George Airy tried it at Greenwich on a star, with an appropriate zenith sector full of water. Stars were seen through the water telescope precisely as through an air telescope. A negative result again.

Stellar observations, however, are unnecessarily difficult. Fresnel had said that a terrestrial source of light would do just as well. He had also (being a man of exceeding genius) predicted that nothing would happen. Hoek has now tried it in perfect manner, and nothing did happen.

Since then Professor Mascart with great pertinacity has attacked the phenomena of thick plates, Newton's rings, double refraction, and the rotary phenomenon of quartz; but he has found absolutely nothing attributable to a stream of ether past the earth.

The only positive result ever supposed to be attained was in a very difficult polarization observation by Fizeau, in 1859. As this has not yet been repeated, it is safest at present to ignore it, though by no means to forget that it wants repeating.

Fizeau also suggested, but did not attempt, what seems an easier experiment, with fore and aft thermopiles and a source between them, to observe the drift of a medium by its convection of energy, but arguments based on the law of exchanges* tend to show, and do show as I think, that a probable alteration of radiating power due to motion through a medium would just compensate the effect otherwise to be expected.

We may summarize most of these statements as follows:

Summary.

Source alone moving produces...	A real and apparent change of wave length. A real but not apparent error in direction. No lag of phase or change of intensity, except that appropriate to altered wave length.

* Lord Rayleigh in *Nature*, March 25, 1892.

Medium alone moving, or source and receiver moving together, produces	No change of frequency. No error in direction. A real lag of phase, but undetectable without control over the medium. A change of intensity corresponding to different distance, but compensated by change of radiating power.
Receiver alone moving produces	An apparent change of wave length. An apparent error in direction. No change of phase or of intensity, except that appropriate to different virtual velocity of light.

I may say, then, that not a single optical phenomenon is able to show the existence of an ether stream near the earth. All optics goes on precisely as if the ether were stagnant with respect to the earth.

Well then perhaps it *is* stagnant. The experiments I have quoted do not prove that it is so. They are equally consistent with its perfect freedom and with its absolute stagnation; though they are not consistent with any intermediate position. Certainly, if the ether were stagnant, nothing could be simpler than their explanation.

The only phenomena then difficult to explain would be those depending on light coming from distant regions through all the layers of more or less dragged ether. The theory of astronomical aberration would be seriously complicated; in its present form it would be upset. But it is never wise to control facts by a theory; it is better to invent some experiment that will give a different result in stagnant and in free ether. None of those experiments so far described are really discriminative. They are, as I say, consistent with either hypothesis, though not very obviously so.

Mr. Michelson, however, of the United States, has invented a plan that will discriminate, and, what is much more remarkable, he has carried it out.

That it is an exceptionally difficult experiment you will realize when I say that the experiment will fail altogether unless 1 part in 400 millions can be clearly detected.

Mr. Michelson reckons that by his latest arrangement he could see 1 in 4,000 millions if it existed (which is equivalent to detecting an error of $\frac{1}{1000}$ of an inch in a length of forty miles); but he saw nothing. Everything behaved precisely as if the ether were stagnant; as if the earth carried with it all the ether in its immediate neighborhood. And that is his conclusion. If he can repeat it and get a different result on the top of a mountain, that conclusion may be considered established. At present it must be regarded as tentative.

I have not time to go into the details of his experiment (it is described in *Phil. Mag.*, 1887), but I may say that it depends on no doubtful properties of transparent substances, but on the straightforward fundamental principle underlying all such simple facts as that it takes longer to row a certain distance and back up and down stream than it does to row the same distance in still water; or that it takes longer to run up and down a hill than to run the same distance laid out flat; or that it costs more to buy a certain number of oranges at three a penny and an equal number at two a penny than it does to buy the whole lot at five for twopence.

Hence, although there may be some way of getting round Mr. Michelson's experiment, there is no obvious way; and I conjecture that if the true conclusion be not that the ether near the earth is stagnant, the experiment will lead to some other important and unknown fact.

The balance of evidence at this stage seems to incline in the sense that the earth carries the neighboring ether with it.

But now put the question another way. *Can* matter carry neighboring ether with it when it moves? Abandon the earth altogether; its motion is very quick but too uncontrollable, and it always gives negative results. Take a lump of matter that you can deal with, and see if it pulls any ether along.

That is the experiment I set myself to perform, and which, in the course of the last year, I have performed.

I take a steel disk, or rather a couple of steel disks clamped together with a space between. I mount it on a vertical axis and spin it like a teetotum as fast as it will stand without flying to pieces. Then I take a parallel beam of light, split it into two by a semi-transparent mirror (Michelson's method), a piece of glass silvered so thinly that it lets half the light through and reflects the other half; and I send the two halves of this split beam round and round in opposite directions in the space between the disks. They may thus travel a distance of 20 or 30 or 40 feet. Ultimately they are allowed to meet and enter a telescope. If they have gone quite identical distances, they need not interfere, but usually the distances will differ by a hundred thousandth of an inch or so, which is quite enough to bring about interference.

The mirrors which reflect the light round and round between the disks are shown in Fig. 10. If they form an accurate square, the last two images will coincide, but if the mirrors are the least inclined to one another at any unaliquot part of 360°, the last image splits into two, as in the kaleidoscope is well known, and the interference bands may be regarded as resulting from those two sources. The central white band bisects normally the distance between them, and their amount of separation determines the width of the bands. There are many interesting optical details here, but I shall not go into them.

The thing to observe is whether the motion of the disks is able to replace a bright band by a dark one, or *vice versa*. If it does, it means that one of the half beams, viz., that which is traveling in the same direction as the disks, is helped on a trifle, equivalent to a shortening of journey by some quarter millionth of an inch or so in the whole length of 30 feet, while the other half beam, viz., that traveling against the motion of the disks, is retarded, or its path virtually lengthened, by the same amount.

If this acceleration and retardation actually occur, waves which did not interfere on meeting before the disks moved will interfere now, for one will arrive at the common goal half a length behind the other.

Now a gradual change of bright space to dark, and *vice versa*, shows itself, to an observer looking at the bands, as a gradual change of position of the bright stripes, or a shift of the bands. A shift of the bands, and especially of the middle white band, which is much more stable than the others, is what we look for.

At first I saw plenty of shift. In the first experiment the bands sailed across the field as the disks got up speed until the cross wire had traversed a band and a half. The conditions were such that, had the ether whirled at the full speed of the disks, I should have seen a shift of three bands. It looked very much as if the light were helped along at half the speed of the moving matter, just as it is inside water.

On stopping the disks the bands returned to their old position. On starting them again in the opposite direction, the bands ought to have shifted the other way too; but they did not; they went the same way as before.

The shift was therefore wholly spurious; it was caused by the centrifugal force of the blast of air thrown off from the moving disks. The mirrors and frame had to be protected from this. Many other small changes had to be made, and gradually the spurious shifts have been reduced and reduced, largely by the skill and patience of my assistant, Mr. Davies, until now there is barely a trace of them.

But the experiment is not an easy one. Not only does the blast exert pressure, but at high speeds the churning of the air makes it quite hot. Moreover, the tremor of the whirling machine, in which some four or five horse power is sometimes being expended, is but too liable to communicate itself to the optical part of the apparatus. Of course elaborate precautions are taken against this. Although the two parts, the mechanical and the optical, are so close together, their supports are entirely independent. But they have to rest on the same earth, and hence communicated tremors are not absent. They are the cause of all the slight residual trouble.

The method of observation now consists in setting a wire of the micrometer accurately in the center of the middle band, while another wire is usually set on the first band to the left. Then the micrometer heads are read, and the setting repeated once or twice to see how closely and dependably they can be set in the same position. Then we begin to spin the disks, and when they are going at some high speed, measured by a siren note and in other ways, the micrometer wires are

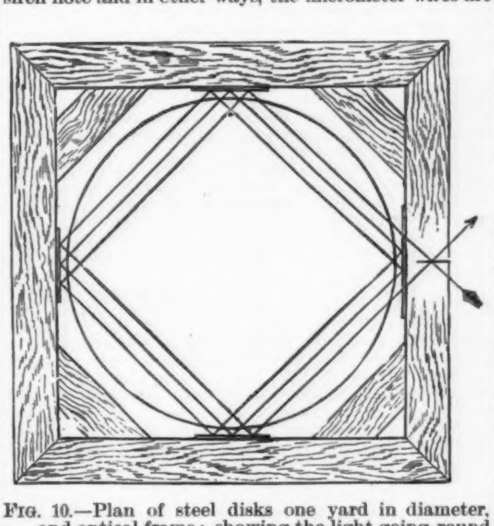


FIG. 10.—Plan of steel disks one yard in diameter, and optical frame; showing the light going round and round, three times each way, between the disks.

reset and read—reset several times and read each time. Then the disks are stopped and more readings taken. Then their motion is reversed, the wires set and read again; and finally the motion is once more stopped and another set of readings taken. By this means the absolute shift of middle band and its relative interpretation in terms of wave length are simultaneously obtained; for the distance from the one wire to the other, which is often two revolutions of a micrometer head, represents a whole wave length shift.

In the best experiments I do still often see something like a fiftieth of a band shift, but it is caused by residual spurious causes, for it repeats itself with sufficient accuracy in the same direction when the disks are spun the other way round.

Of real reversible shift, due to motion of the ether, I see nothing. I do not believe the ether moves. It does not move at a five hundredth part of the speed of the steel disks. I hope to go further, but my conclusion so far is that such things as circular saws, flywheels, railway trains, and all ordinary masses of matter do not appreciably carry the ether with them. Their motion does not seem to disturb it in the least.

The presumption is that the same is true for the earth; but the earth is a big body. It is conceivable that so great a mass may be able to act when a small mass would fail. I would not like to be too sure about the earth. What I do feel already pretty sure of is, that if moving matter disturbs ether in its neighborhood at all, it does by some minute action, comparable in amount perhaps to gravitation, and possibly by means of the same property as that to which gravitation is due—not by anything that can fairly be likened to ethereal viscosity.

SALOPHEN.

DR. FROLICH, who has experimented with this new remedy for rheumatism, found it invariably efficacious so far as relieving pain within a few days was concerned, but, like other salicylic preparations, it does not prevent relapses. He prefers it, however, because it is decomposed in the intestines, and hence does not irritate the stomach: it can be given in large doses and continued a long time, and it is tasteless.

THE DETERMINATION OF CARBON DIOXIDE IN THE AIR OF BUILDINGS.

By AUGUSTUS H. GILL, Ph.D.

IN the only treatise upon air analysis in the English language, the method given for the determination of carbon dioxide admits of no great accuracy, as results varying 6 per cent. from an average, and 10 per cent. among themselves, would indicate. The writer recommends the following method, which has been in use in his laboratory in almost the present form for fifteen years.

Both methods are those of Pettenkofer,* which consists in bringing a large known volume of air in contact with standard barium hydrate solution.

The bottles used for containing the samples are ordinary green glass gallon or two gallon bottles, holding 4,400 or 8,800 c. c. respectively; they are calibrated with water, by weighing upon scales sensitive to 5 gms., and their capacity marked upon them with a diamond. They may be conveniently transported from place to place in a partitioned basket made for the purpose.

The bellows there suggested (wooden disks joined by a strip of rubber, with no valves) was found troublesome to manipulate, and has given way to one about to be described. The nozzle of an ordinary 9 inch blacksmith's bellows is removed and the opening fitted with a valve opening outward; this is made by tying a bit of chamois skin over a cork which fits over a tube passing into the nozzle opening. By varying the position of the cork, different degrees of tightness of valve are attained. To the other opening of the bellows, closed with its usual valve, is fitted a cork carrying a four foot piece of [illegible] inch rubber tubing terminating in a light two foot brass tube, bent for insertion into the bottles. Instead of the bellows, a small 6 inch fan blower, the driving parts of which are connected by rubber bands to render it noiseless, can be used if it is desired to decrease the bulk of the apparatus.

The bottle is fitted with a rubber stopper, carrying a glass tube, closed by a small unperforated rubber nipple; both the stopper and nipple have been digested with caustic potash and thoroughly washed to remove the superficial zinc oxide.

The air to be tested is drawn into the bottle by means of the bellows, fifteen strokes being taken, sufficing to fill a four liter bottle four times, thus insuring a representative sample. In collecting this sample the atmosphere in the room should be as quiet as possible; care must be exercised to avoid the draughts or the proximity of people.

When used the bottles should be *clean* and *dry*; by clean is understood containing nothing to affect the barium hydrate used. When wet the standard barium hydrate is diluted, and as the whole of it is not used, the determination is lost, unless the amount of water present be accurately known.

The operation of drying the bottles is by no means as troublesome as it would appear. A small closet heated by steam and provided with suction, enabling a current of hot air to be drawn into the botles, suffices to dry a dozen bottles in half an hour. The samples are brought into the laboratory, the temperature of which should be a little higher than that of the place where they were taken, and allowed to stand half an hour, or until they have attained its temperature.

Fifty c. c. of the standard barium hydrate are now run in rapidly from a burette (the tip passing entirely through the tube in the stopper), the nipple replaced, and the solution spread completely over the sides of the bottle while waiting three minutes for the draining of the burette, before reading, unless it be graduated to deliver 50 c. c. The bottle is now placed upon its side, and shaken at intervals for 40–60 minutes, taking care that the whole surface of the bottle is moistened with the solution each time. The time of absorption, ten minutes, recommended in the treatise, is much too short, as the disappearance of the last traces of carbon dioxide is very slow indeed, half an hour in many cases being insufficient.

At the time at which the barium hydrate is added the temperature and pressure should be noted. At the end of the above period, shake well to insure homogeneity of the solution, remove the cap from the tube, and invert the large bottle quickly over a 50 c.c. glass stoppered bottle, so that the solution shall come in contact with the air as little as possible. Without waiting for the bottle to drain, withdraw a portion of 15 or 25 c.c. with a narrow stemmed spherical bulbed pipette and titrate with sulphuric acid† (1 c. c. equals 1 mgm. CO_2), using rosolic acid as an indicator. The difference between the number of cubic centimeters of standard acid required to neutralize the amount of barium hydrate (*e. g.*, 50 c. c.), before and after absorption, gives the number of milligrammes of carbon dioxide present in the bottle.

This is expressed in cubic centimeters under standard conditions, and divided by the capacity of the bottle under standard conditions, and the results reported in parts per 10,000. To reduce the air in the bottle to standard conditions, a hygrometric measurement of the air in the room from which the sample was taken is necessary. This, in ordinary cases, is usually omitted, as the object of the investigation is *comparative* results, as regards the efficiency of ventilation, and the rooms in the same building would not vary appreciably in the amount of moisture in the atmosphere. This correction may make a difference of about 0·15 part per 10,000.

Some of the results obtained by our students by the preceding method are as follows:

Expressed in parts of CO_2 per 10,000.

Room No. 24.	Room No. 43.	Room No. 37.	Room No. 34.	Room No. 34.	Room No. 23.	Outside Air.
5·54	7·34	4·94	5·16	5·53	4·54	3·13
5·59	7·27	4·89	5·12	5·52	4·46	3·09

The subjoined results are interesting as showing rate of vitiation of the air in a well ventilated lecture room.

* Annalen, 2, Supp. Band, p. 1.

† Sulphuric acid, in distinction to oxalic acid, enables one to estimate the excess of barium hydrate in presence of the suspended barium carbonate, and also of caustic alkali, which is a frequent impurity of commercial barium hydrate. Professor Johnson, in the American edition of *Fresenius' Quantitative Analysis*, calls attention to the fact that the normal alkaline oxalates decompose the alkaline earthy carbonates, so that the reaction continues alkaline if the least trace of soda or potash be present. The sulphuric acid may be prepared by diluting 40·81 c. c. normal sulphuric acid to a liter.

It is 15 feet high, having a capacity of 24,000 cubic feet, and supplied with 185,000 feet of air per hour, from three flues; 225 students were present.

	Time.	1st Day. Pts. CO_2 in 10,000.	2d Day.
Before lecture	11.35	3·89	4·54
"	12.10	6·07	9·93
"	12.20	8·44	10·27
"	12.30	11·29	10·43
"	12.40	11·38	10·50
"	12.50	10·56	10·58
End of lecture	1.00	6·62	7·19
"	1.30	3·72	6·10

The following shows the distribution of carbon dioxide in an ordinary theater:

	CO_2 per 10,000.
Floor	39·13 pts.
First balcony	42·86 "
Second balcony	44·72 "
Gallery	48·94 "

Laboratory of Sanitary Chemistry and Gas Analysis, Massachusetts Institute of Technology, Boston, Mass., U. S. A.

PEROXIDE OF SODIUM.

By M. PRUD'HOMME.

UNTIL recently peroxide of sodium was only known as laboratory product. The peroxides of potassium and sodium were known to Gay Lussac and Thinard, in 1810, and were obtained by them in small quantities. These chemists gave them the formulæ KO_3 and Na_2O_3 (old notation). The study of these substances was again entered upon in 1862 by Vernon Harcourt, whose analyses led him to the formulæ K_2O_4 and Na_2O_3, instead of K_2O_3 and Na_2O_2. He prepared them by heating the metals in an excess of oxygen in a silver vessel, and Na_2O_2 is now made on the commercial scale, we believe, by the Aluminum Co., Limited, Oldbury.

ITS PREPARATION.

To avoid the fusion of the product it is well to commence the oxidation in a current of dry air, and then to replace this by pure oxygen. Peroxide is also formed when potassium hydrate is kept fused in a silver crucible in contact with the air.

In 1886, H. Carrington Bolton devised a simple method for showing the formation of these peroxides as a lecture experiment, by dropping bits of potassium or sodium into fused nitrate of potassium or sodium. The metal burns with a bright light and the mass becomes colored a deep red in the case of potassium, becoming yellow on cooling, and yellowish red with sodium, becoming colorless on cooling. Finally, in 1876, Fairley obtained the sodium compound crystallized with one molecule of water by adding peroxide of hydrogen to an excess of caustic soda solution of 20 per cent. and then pouring into alcohol.

The firm of E. De Haen has just introduced, at the price of 5 francs per kilo., under the name of sodium superoxide, a substance which is identical with sodium peroxide. The German patent of February 3, 1892, not having yet been published, we are not aware of the industrial method by which the substance is prepared. It is, however, probable that it is obtained from metallic sodium, for it seems to inclose particles of this metal, which produce slight explosions when brought into contact with water. It is a yellowish porous matter and partly in the state of powder.

GENERAL PROPERTIES.

It dissolves in water, producing a considerable rise of temperature and evolving a certain amount of oxygen which provokes coughing. It must be kept away from moisture, as it is very hygroscopic; exposed to air, it gains 20 per cent. in weight in 24 hours, even when the surface is not disturbed. Its handling may present some danger when it is in contact with water and organic matter simultaneously. It can, for example, be heated with aniline (azobenzine being formed) or with benzine, but if water be added to the mixture, flames are produced, accompanied in the case of benzine by an explosion.

The commercial article contains about 20 per cent. of active oxygen, corresponding to the formulæ Na_2O_2 (20·51 per cent.), while peroxide of barium only contains about 8 per cent., and hydrogen peroxide (12 vols.) about 1·5 per cent. It dissolves without evolution of oxygen in dilute acids when the temperature is not allowed to rise, and a solution of hydrogen peroxide is thus produced.

Cellulose is violently attacked by a warm, tolerably concentrated solution (15 per cent.) of sodium peroxide. It becomes yellow and disintegrates; when washed and treated with a weak acid, it takes a deep shade in a bath of methylene blue.

This phenomenon is also produced, as is already known, when mercerized cotton is boiled with caustic soda solution containing hydrogen peroxide. The peroxide is too alkaline to be employed directly for the bleaching of textile fibers of animal origin, such as silk and wool. The processes recommended by E. De Haen are, therefore, based on the use of peroxide of magnesium, the use of which for bleaching has already been studied, and which has been shown to be more stable than peroxide of hydrogen.

Three parts of magnesium sulphate and one of sodium peroxide are, therefore, dissolved in water, these proportions corresponding approximately with those required by theory:

$$MgSO_4\ 7\,aq. + Na_2O_2 = SO_4Na_2 + Mg\,O_2.$$

USE IN BLEACHING WOOL.

E. De Haen's process: Free the wool thoroughly from grease, and put into a bath at 30° containing 30 per cent. of the weight of material of sulphate of magnesium free from chlorine, turn several times, remove, add peroxide of sodium (10 per cent. on the wool), put in again, raise the temperature to 60-70°, keep in for ¾-1 hour, take out, pass into dilute sulphuric acid to remove the magnesia, wash and dry.

BLEACHING OF TUSSUR.

Scour the material, and remove the soap in the usual way. For every 10 kilos. of material prepare a bath of 2,500 liters of water at 30-35°, dissolve 90 kilos. of magnesium sulphate free from chlorine, give three or four turns, remove and add in two or three lots 30 kilos. of peroxide of sodium. After each introduction of this stir the bath well, then as soon as the whole has been dissolved, raise the temperature to 80-95° and put in the goods. The operation lasts 1½-2 hours. Remove the excess of magnesia by dilute sulphuric acid, wash, drain, and dry or pass on to the dyeing. The process can be applied to ivory, feathers, bone and bristles.

BLEACHING OF MIXED SILK TISSUES (WOOL AND SILK, COTTON AND SILK).

Scour the pieces well before bleaching, and remove the soap by repeated washings. Enter the tissue into a bath at 30° containing, according to their shade, 30-36 per cent. magnesium sulphate free from chlorine, give several turns, remove, add 10-12 per cent. of peroxide, stir, introduce the goods, raise to 95° in ¾ hour, and finally boil. Finish as before. For 100 meters of tissue, 0·6 m. broad and weighing about 5 kilos., use 250 liters of water.—*Chem. Tr. Jour.*

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